FEB 2 1949

ENGINEERING NEWS-RECORD

DECEMBER 23, 1948

Rigid frames give 200-ft. of clear working space in Colorado transit shed

ARTICLES ON:

ELECTRICAL LOGS AID WELL-WATER FORECASTS

SYMPOSIUM ON NEW PAVEMENT DESIGN APPROACH

A McGRAW-HILL PUBLICATION

Combating a double dose of corrosion here

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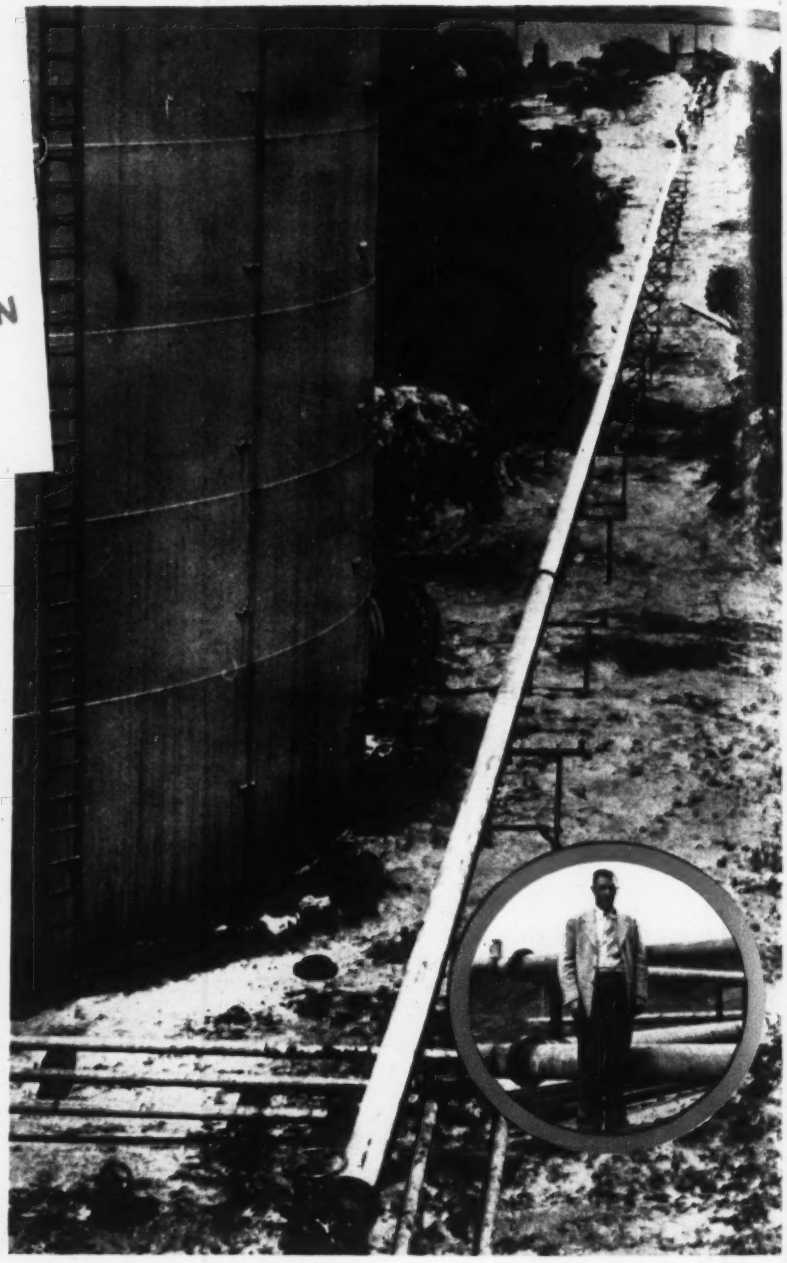

The 1800-feet of space that separates the oil storage tanks of Coastal Terminal Inc., Charleston, S.C., from the river terminal docks is filled with hazards for the pipe line. Both the atmosphere and the soil are actively corrosive. To safeguard the transfer system, the engineers use wrought iron. Two carloads of 10-inch Byers Wrought Iron pipe were installed on the project.

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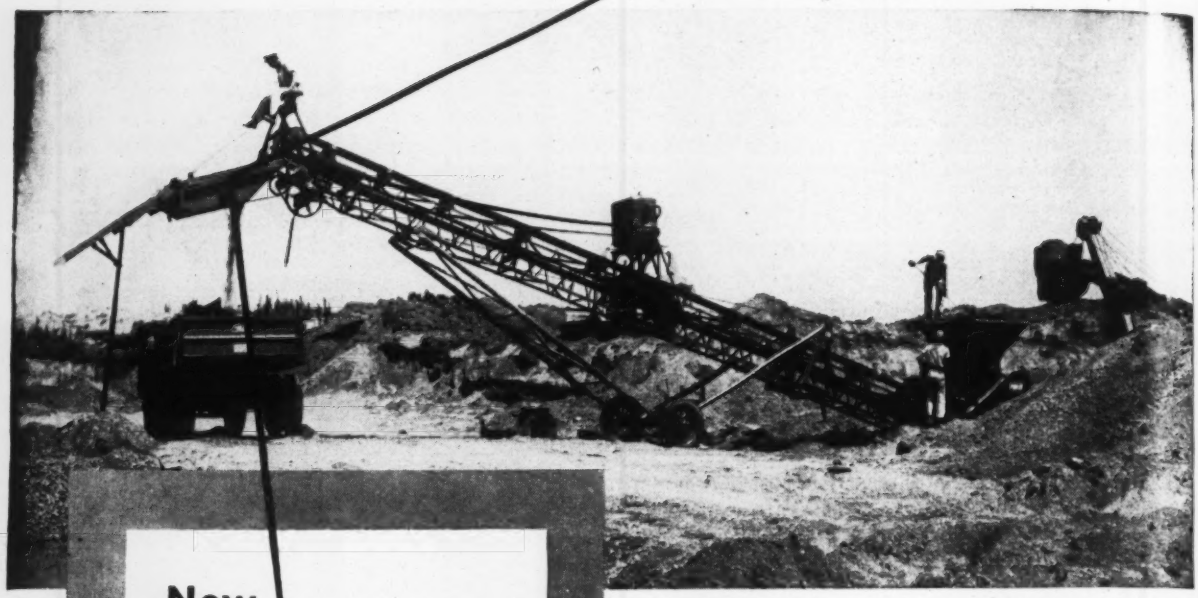

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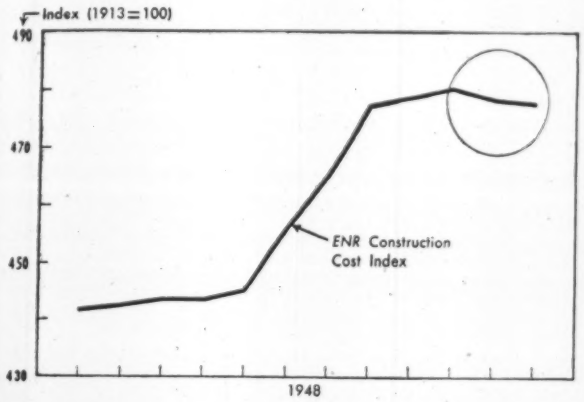
CONSTRUCTION TRENDS



Index trend turns down

Engineering News-Record's Index of Construction Costs dropped slightly in November, and dropped again in December — the first extended dip in its upward march since 1939.

The turn is good news for the entire industry. It's not likely to be the forerunner of a major drop in costs. **It probably marks the beginning of a period of stable prices barring more inflation.**

It makes the cost outlook for 1949 this: Costs are leveling out, will probably stabilize through the year somewhere close to today's level. Chances are they won't vary more than 5% from the December ENR cost index figure of 477.

True, 1949 is more apt to see costs rise 5% than fall that amount. The railroads, for example, are asking a 13% rise in freight rates. They seem sure to get part, if not all, of it. That rise will be reflected in steel, cement, and lumber costs.

Unions expect another round of wage increases. Some of the pressure behind their claims will be eased by falling food prices. Food is coming down now. By next summer, supermarket prices may be down 10% from this fall's peaks. But with labor still short, particularly in the skilled trades, contractors expect another bump in wage rates in the spring.

Then, too, lumber prices dropped as business fell off this fall—and that is reflected somewhat in the ENR cost index, which dropped in November and December, largely because of the dip in lumber prices. Labor and steel costs remained the same. Cement even moved up slightly. Next spring, when housing picks up again, lumber prices may become firm or even gain slightly. If that happens, the index will tend to rise again.

All these things mean that costs are sticky—they are not apt to slide off suddenly as they did after World War I. The industry still has a big holding operation before it to keep them from going still higher.

The leveling-out that's showing today in the index is good news if it is accompanied by stabilization of actual job costs. It could be an aid to contractors in reducing contingency items when they know that costs won't jump as the project goes along.

It's good news particularly to people who are concerned with public works. Stabilizing costs will enable many state and municipal projects to go ahead. Officials won't fear a rise in costs during construction that would mean re-financing the whole project or cutting back plans to stay within the original estimate.

It's good news to construction's customers in another way. Efficiency is improving particularly in housing. Materials production is hitting new records, making the flow of materials to the site better. Contractors are doing more work in the shop, less on the site. Power tools are taking over many kinds of jobs. Most of the gains that can be made in these ways have already been realized. But, even with these gains, there's still room for some improvement. Improved efficiencies and increased total production in a period of stable costs can only mean better construction buys for construction's customers.

All this has already helped substantially to hold down the cost to the customer. And with efficiency gaining, contractors can offset another small rise in materials and labor costs—and in so doing still hold the customer's bill down.

It brightens the industry's prospect for 1949. It can help keep construction going at a high level through the year—if we don't have another large dose of inflation.

As it looks now, contractors have a good chance to hold the line on costs. But, if the U. S. defense program is stepped up, say $5 billion or more, costs will get another boost. Steel, lumber, cement—and manpower—will be harder to get. The same sort of thing could happen if the government starts a new series of big dam projects and begins a heavy housing program.

Much more likely, however, is that military expenditures will rise, but under limits, and any new construction programs will get underway slowly.

That means—barring war or other calamity—that:

Construction is going into its biggest postwar year, with good chances of setting new volume records—and of holding the line on costs.

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THE CONSTRUCTION WEEK

SECOND TRY ON SEAWAY—New York State plans to develop the St. Lawrence river for hydro power went on the shelf in Washington this week, as it became apparent that President Truman will have another try at getting the U. S. and Canada to build the original seaway project. Early in the recent campaign Mr. Truman opposed the New York Power Authority proposal for development of power in the river's International Rapids in a joint operation with the Ontario Hydro-electric Commission. At press conference interviews last week, the President repeated that the job is one that the national governments of the U. S. and Canada should tackle.

CULVERTS STILL COMING—The restraint-of-trade suit filed recently by the Department of Justice against the Republic Steel Corp. and the Toncan Culvert Manufacturers Association will have little immediate effect on either the manufacture, sale or cost of corrugated metal pipe culverts. Sales contracts by which the association members bought all sheet steel from Republic and were allotted designated distribution areas for their metal pipe culverts have been cancelled. This merely means that the various member manufacturers now are free to compete with each other in the sale of culverts, while purchasing sheet steel from Republic or any other steel mill on a non-allotment basis.

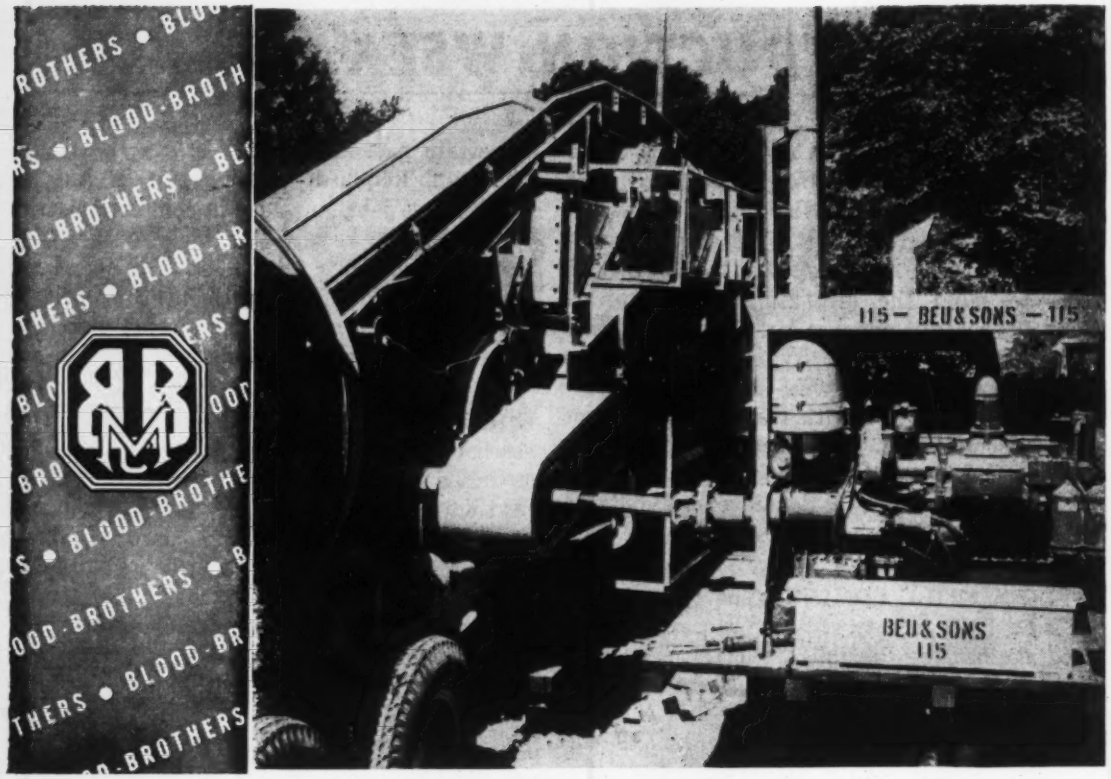
MONEY FOR MINING—It isn't often that the Export-Import Bank lends a company money without a government guarantee, but it has done that to the tune of $5,000,000 in the case of Steep Rock Iron Mines, Ltd., of Ontario, Canada. Located about 100 miles north of Duluth, the mines (ENR Dec. 14, 1944, p. 100) hold a rich iron ore body practically all of which has been imported into the U. S. to meet urgent steel demands. New financing will make it possible for the company to buy U. S. equipment—chiefly earthmoving and general mining machinery—and engineering services to open a second and larger ore body.

JET PLANE PROBLEM MET—Damage to taxiways and aprons from jet fuel spillage is no cause for worry for at least five years yet, the designers of the new Friendship International Airport at Baltimore have concluded. It will be that long before jet planes are in commercial use. By then, if the densely-graded asphaltic concrete used shows itself subject to damage, surface protection on the small areas affected can be supplied by tar or certain patented materials, say the engineers Whitman, Requardt—Greiner Co. & Associates. By the time jet planes are in commercial use, the pavement may have to be thickened anyway for heavier loads, they reason. So why spend money now on special surface treatment, they asked General Donald H. Connolly, the airport director. He concurred, and the jet plane problem was solved.

EQUIPMENT OUTLOOK GOOD—The current steel shortages notwithstanding, most lines of construction equipment should be more plentiful by next spring. Third-quarter reports by the Associated Equipment Distributors showed equipment deliveries definitely improving in 12 of the 15 regions covered in the survey. One region reported no improvement, while deliveries on motor graders, crawler-mounted equipment, and heavy shovels and cranes were reported still tight in the other two regions. Seasonal slowdown in construction this winter will reduce current demand for much of this equipment, particularly in roadbuilding, thus increasing manufacturers' inventories for construction requirements in 1949.

MORE URBAN EXPRESSWAY FUNDS?—Increasing traffic congestion in metropolitan centers, accentuated by the time lag in completing freeway systems in several large cities is focusing attention on the need for more federal funds for this construction. One of the leaders in this movement is the Michigan Good Roads Association which is driving for 500,000 signatures on petitions requesting Congress to revise the formula for distributing federal funds so that a larger percentage will be made available for urban expressway construction.

MEXICO WANTS PROGRESS—Signs multiply that Mexico's desire for progress may yet overcome the nationalistic pride that caused expropriation of U. S., British and Dutch oil properties in 1938. Since the 1920's, Mexico's oil exports have dropped from 180 million to 15 million barrels a year—a big loss in dollars badly needed for President Aleman's plans for industrial and agricultural development. Both on business and governmental levels, efforts are being made to get American oil companies back. Mexico has asked for and received a $30,000,000 Export-Import Bank credit for factory building and hydro development and wants $200,000,000 more from the World Bank. U. S. industries are being invited to go to Mexico, and more engineers should be needed soon.



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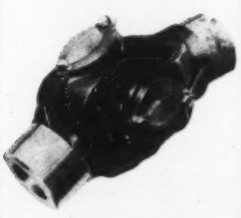


Revision Urgent

THE overtime-on-overtime wage situation (p.45) may not be understood completely by the buyers of construction, contractors and unions (and it is completely confusing to us), but each group detects implications that urge speedy remedial legislation. Owners see higher contract prices. Contractors concur, visualizing higher total wages and greater accounting costs plus trouble from uncertainties as to the present law's applicability to a given job. Even the unions are scared. In prosperous times the overtime-on-overtime decision might increase the total income of union members, but offsetting that is the possibility that it might destroy the concept of premium pay for "unfavorable hours" or establish undesirable pay rate inequalities among workers. At the least the Supreme Court's decision casts doubt on the validity of construction labor procedures. These procedures are well understood, and are administered with little friction. No element of the construction industry wants either the confusion or the maladjustment that is threatened by the court's complex construction of a law whose wording is so simple. Nor will the public derive any benefit from it. The overtime provision of the wage-hour law should be amended quickly in the interests of clarity and simple administration.

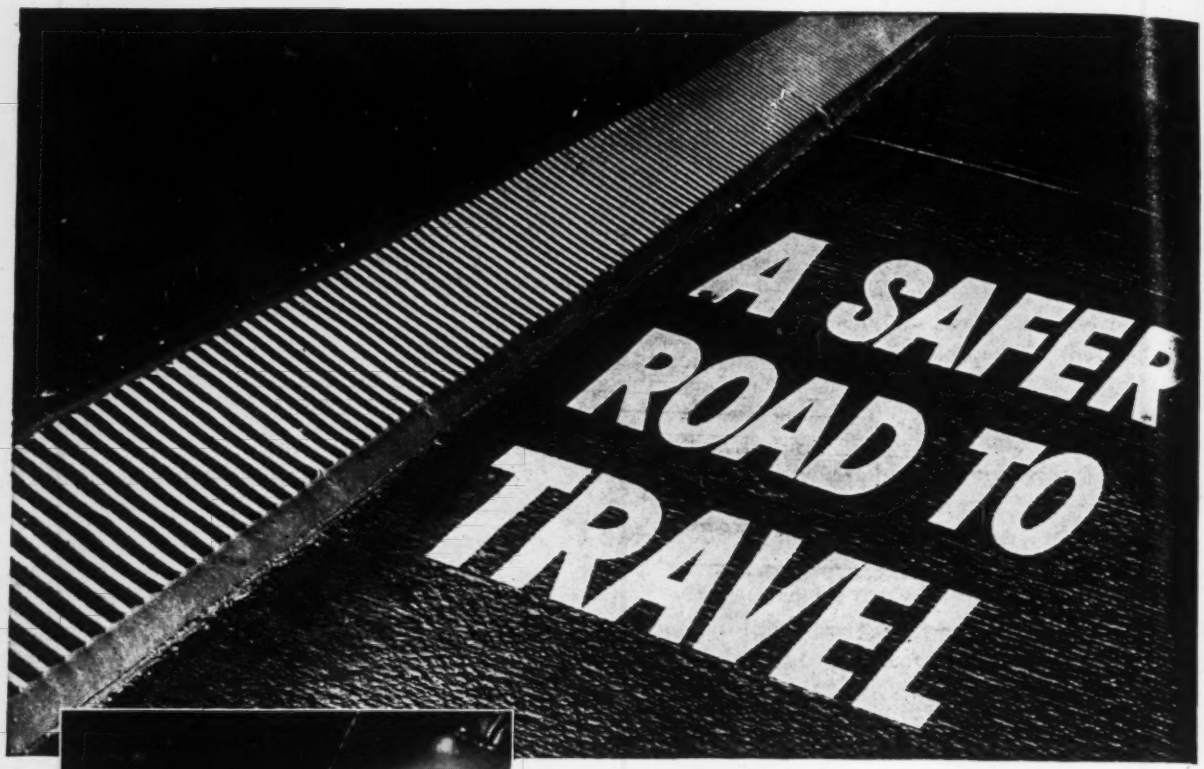
Over-Short on Analysis

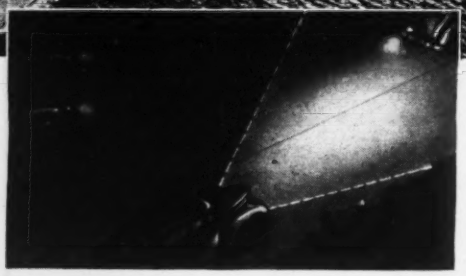
OCCASIONALLY a great deal is said in very few words. That happened at the opening general session of the Highway Research Board meeting in Washington when F. V. Reagel, chairman of the board, told the members, who were to listen to 100 papers, that their organization was "over long on data and over short on analysis". A major function of the board, he said, should be to "translate findings into practice." The significance of Mr. Reagel's statement goes far beyond the Highway Research Board, because the board is no worse offender than other scientific organizations. In fact, during the war years it did notable work in quickly translating findings into concise, useful pamphlets. But in normal times most engineering organizations are content to assemble a lot of information in unrelated papers without making any plans for the synthesis of the information they contain. As a result, the art does not make the progress that it otherwise could. This progress would be greater if every paper reporting the results of an investigation were required to present some kind of a conclusion, and if the published conclusions from related papers were then to be analyzed and their implications drawn. The directors of every organization that we know of should take Mr. Reagel's comment to heart.

The Great Debate

IN WASHINGTON these days the seeds of a planned economy are being fondled. If the maximum demands of the military for federal spending are to be met, the seeds must be planted. If military expenditures are not increased above the $15 billion ceiling fixed by President Truman last fall, such elements of a planned economy as allocation of key materials, direction of labor to vital jobs, and price and wage controls can probably be avoided. It is the old problem of guns or butter. This time, as compared to 1939, however, our resources are already being fully utilized. There can be no possibility of the co-existence of normal standards of living alongside all-out military preparedness. Not only is there no extra supply of materials or manpower to be applied to more war needs, any attempt to expand our economy over current levels runs the risk of generating dangerous inflation.

With these dire consequences plain for all to see, the great debate will soon begin. It will be full of portent for the construction industry. Regardless of outcome, full utilization of its resources and abilities will no doubt be required. More industrial building would be a probability under an expanded military program. Public works in such areas as transportation and electric power would be enlarged. In contrast, housing, commercial building, schools and sanitation would suffer to the extent that each project would have to justify itself according to its contribution to the military objective rather to an improved standard of living. But the greatest dislocation would arise from the imposition of controls. A different industry than we have today will result if military spending is increased as much as the $3 billion that is being considered. That is why the great debate on the economic supply and the military demand is of such concern and consequence.





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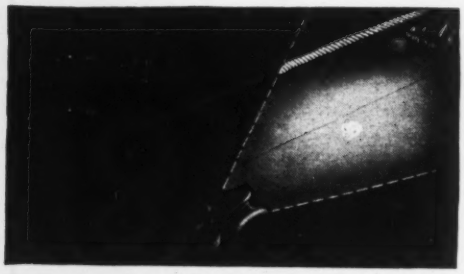

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ENGINEERING NEWS-RECORD

DECEMBER 23, 1948 VOL. 141 NO. 26

Overtime-on-overtime ruling spurs wage-hour law changes

Confusion over Supreme Court decision starts move by U. S. Labor department for legislation nullifying ruling—Officials explain application to construction industry

By Joseph Gambatese
Washington News Bureau

Secretary of Labor Maurice J. Tobin and Wage-Hour Administrator William R. McComb are drafting proposed changes to the Wage-Hour Law which would nullify the Supreme Court's "overtime on overtime" decision reached last June in the recent Bay Ridge stevedoring case.

[The Court later refused to reconsider its decision, and the wage-hour administrator began enforcing it (ENR Oct. 21, p. 5).]

The Tobin-McComb plan has the backing of the American Federation of Labor and is likely to be adopted by the Democratic-controlled 81st Congress next year.

In negotiations that led to the settlement of the East Coast dock strike, Tobin promised to ask Congress to validate the traditional longshore contract, under which dock workers got time and a half "overtime" for any work outside the regular daytime week-day hours. The Supreme Court raised a threat to continuance of those premium payments when it held that they were not true "overtime", but merely extra compensation for working at unusual hours.

Thus, for work beyond 40 hours, employers would have to include that time and a half in the "regular rate" of pay and pay time and a half on top of it.

Effect of proposal

Tobin's proposal, if adopted, will legalize as overtime pay the time and a half which some contractors have been paying for any work performed before 8 A. M. or after 5 P. M. and for holiday, Saturday and Sunday work.

This goes further than the amendments McComb had in mind, but no doubt it will be included in the administration's plan. McComb, in his tentative draft of what Congress should do, urged definition of the term "regular rate" on which time and a half overtime must be paid. He would classify as "real overtime" all time and half paid after eight hours a day and on holidays, Saturdays, Sundays and the sixth or seventh day of a work week. He would not have included time and a half for night work as such, as Tobin contemplates doing.

What is overtime?

How the Wage-Hour Law, as it now stands under the Bay Ridge decision, affects the construction industry was explained by Harry Weiss, director of the wage-hour office's wage determinations and exemption's branch, at a meeting of the Associated General Contractors' Northern California Chapter in San Francisco, Dec. 3.

Mr. Weiss declared that only those premium payments "that are contingent upon the employee's having previously worked a specified number of hours or days, in accordance with a bona fide standard, may be considered true overtime payments. This means that time and a half for working at night, on holidays, Saturdays or Sundays is merely higher straight-time pay for working at an undesirable time.

"There is no single and exclusive test for what constitutes a bona fide standard," he added. "It may have been established through collective bargaining or because of statutory requirements, or as a result of the employer's established practice."

He gave these examples of what extra payments are true overtime premiums which don't have to be included in the regular rate and may be credited toward any overtime pay due under the law:

1. Premium pay, under a union contract, for work beyond a specified standard number of hours—eight a day or 35 a week.

2. Extra pay for night, Saturday or Sunday work, if the pattern of employment establishes the fact that that work normally falls within true overtime hours set by contract or practice. That is, after the employees have previously worked the period specified as the bona fide standard. This is true even though the employee, on infrequent occasions, may not work the full standard of hours because of an occasional excusable ab-

(*Continued on p. 47*)

AGC group talks overtime mix-up cures

The confusing results of the Supreme Court's overtime-on-overtime wage decision and highway construction programs were topics of the annual convention of the New York State Chapter, Associated General Contractors, in New York City Dec. 10-11.

The overtime-on-overtime wage situation, brought into prominence by the recent Supreme Court decision, was discussed by Homer Peters, counsel for the chapter. He stated that making the payroll week begin on Monday is one way of avoiding the confusion that arises out of situations wherein work normally compensable at a premium rate occurs in the first forty hours.

Peters also suggested confining all regular work to the forty straight-time hours. Another approach is to get a specific ruling for every job from the National Labor Relations Board.

In a few informal remarks, H. E. Foreman, A. G. C. managing director, told the group that remedial legislation probably will be enacted by the 81st Congress.

Two officials of the New York State Department of Public Works, Francis L. Brown and E. W. Wendell, discussed highway work in New York. The national picture of one phase of highway work was presented by A. N. Carter, manager of the highway division, Associated General Contractors of America. Speaking on express highways, Carter enumerated the important projects in all parts of the United States.

Charles Lyman of the Lane Construction Co., Meriden, Conn., was elected president of the New York Chapter for the next year, succeeding Michael J. Torpey of New York.

NEWS BRIEFS

Water and Sewers — YOUNGSTOWN, OHIO, plans to proceed with preliminary work preparatory to construction of a sewage treatment plant and intercepting sewer system estimated to cost $10,000,000. The project would help clean up the Mahoning River. . . . Bids were received in BELLEVILLE, ILL., on Dec. 1 for over $1,000,000 worth of bonds which will finance the construction of proposed expansion of municipal sewage treatment. Bids will be taken on about Feb. 1.

Labor—Contractors and union officials in the BINGHAMTON, N. Y., are seeking a basis on which to negotiate wage increases for approximately 2,500 union building craftsmen. Contracts with most of the unions expire Dec. 31. . . . Members of the Granite Cutters International Association (AFL) in BARRE, VT., have accepted a $1 a day increase and the extension of their present contract until May 1950. The move boosts the daily wage to $13.50 per day for 1,300 employees. . . . Conferences over 1949 wage contracts have been opened between contractors and unions in the building industry in and around ROCHESTER, N. Y. . . . After a work stoppage in MARION, IND., carpenters have returned to work at a new wage scale of $1.90 per hour.

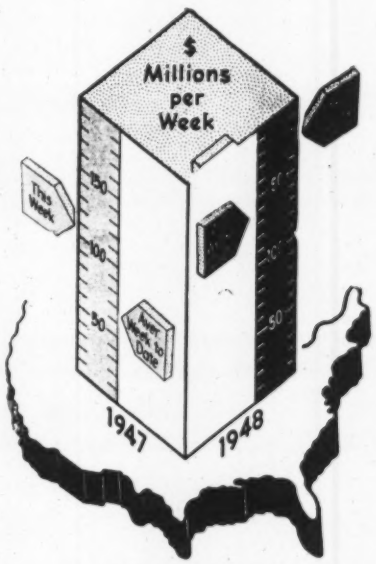
Hospitals—Lankenau Hospital, PHILADELPHIA, PA., will move to a new site in the Overbrook section and build hospital buildings there to cost more than $2,000,000 . . . The provincial technical board of QUEBEC PROVINCE is preparing a report on how to allocate the Hospital grant of $18,000,000, authorized at last session of the legislature for hospital construction . . . R. E. McKee, Dallas, Tex., made a low bid of $17,145,000 on the VA hospital at HOUSTON, TEX. . . . PENNSYLVANIA'S 1949 legislature is expected to be asked to appropriate $60,000,000 for mental hospital construction in the state during the 1949-51 biennium. In the current two-year fiscal period ending May 31, 1949, the state is spending $82,000,000 in mental hospital building and improvement projects . . . Governor Thomas E. Dewey of NEW YORK has ordered full speed ahead on urgently needed buildings at 15 state hospitals. The projects will cost an estimated $80,000,000 instead of the $39,428,000 allocated from the post-war reconstruction fund, the governor said . . . OHIO'S legislature has been asked to provide another $1,000,000 so contracts can be awarded for the Ohio State University's new tuberculosis hospital. On the basis of bids received, the $2,000,000 previously appropriated for the 180-bed hospital would be used up on the unequipped building alone.

Highways — The MONTANA highway planning committee has recommended an annual vehicle use levy and increased gasoline taxes to raise an additional $2,500,000 a year for the state highway system. . . . WASHINGTON'S 1949 state legislature will be asked to increase the state gasoline tax from its present level of 5 cents to 6½ or 7 cents per gallon. Registration fees would also be increased. . . . OHIO will let to contract $25,000,000 worth of highway construction within this month. . . . A $4,767,000 contract for construction of extensive grade crossing elimination facilities on the Long Island Railroad through ROCKVILLE CENTRE, N. Y., has been awarded to Rusciano & Son Corp. of New York City. . . . Raymond E. Baldwin Bridge on U. S. Route 1 near OLD LYME, CONN., was opened for traffic on Dec. 5. . . . In NEW YORK CITY, Mayor O'Dwyer officially opened the final link of the West Side Express Highway along the Hudson River on Manhattan Island. This section, less than a mile, cost $4,376,000.

LEAVING ARMY—Maj. Gen. Robert W. Crawford, president of the Mississippi River Commission, Vicksburg, Miss., for the last three years, will retire shortly to become executive vice-president of the Mississippi Valley Flood Control Association, at Memphis, Tenn. General Crawford will direct the association's valley-wide flood control activities. A 1914 graduate of West Point, he has spent most of his 34 years with the Corps of Engineers in river and harbor construction. During the war he was chief of logistics for General Eisenhower.

ENR INDEX NUMBERS

Index Base = 100		1913	192
Construction Cost	Dec.'48	477.66	229
Building Cost	Dec.'48	355.55	192
Volume	Nov.'48	203	89



Activity This Week

As reported to ENR

Amount of contracts let

(Millions of dollars, continental U. S. only)

	Week of Dec. 23 1948	Cumulative 1948 (52 wks.)	Cumulative 1947 (52 wks.)	% Chge
Federal	$11.2	$940	$6,564	+43
State & Mun.	50.2	2,651	1,835	+44
Total Public	$61.4	$3,591	$2,491	+44
Total Private	111.8	3,550	3,168	+12
U. S. Total	**$173.2**	**$7,141**	**$5,659**	**+26**

Contracts by type of work

	This Week	Cumulative 1948 (52 wks.)	Cumulative 1947 (52 wks.)	% Chge
Waterworks	$2.6	$208	$139	+50
Sewerage	.9	226	175	+29
Bridges	5.3	297	196	+52
Highways	10.4	984	794	+24
Earthwork, Waterways	7.6	510	327	+56
Buildings, Public	29.9	1,147	616	+86
Industrial	40.8	1,087	862	+26
Commercial	69.8	1,873	1,898	−13
Unclassified	5.9	809	652	+24

NOTE: Minimum size projects included are: Waterworks and waterway projects, $28,000; other public works, $50,000; industrial buildings, $68,000; other buildings, $250,000.

New capital for construction

	Cumulative 1948 (52 wks.)	Cumulative 1947 (52 wks.)	% Chge
NON-FEDERAL	$5,174	$3,067	+69
Corporate Securities	2,684	1,641	+64
State and Municipal	1,998	1,178	+70
U. N. Building Loan	65	....	....
Fed. Aid Highway	427	248	+72
FEDERAL	1,559	819	+90
Total Capital	**$6,733**	**$3,886**	**+73**

To seek end of overtime-on-overtime

(*Continued from p. 45*)

-ence due to a holiday, illness or simlar cause.

(However, if as a rule the employees work sporadically during the week, so that Saturday, Sunday and night work does not normally fall after employees have worked a standard number of hours, any premium pay for work at those times would not count as real overtime. Furthermore, the extra pay would have to be included in computing the regular hourly rate.)

What isn't overtime?

These payments, Mr. Weiss said, are not true overtime:

1. Premium pay for work before and after specified shift hours, commonly called "clock-overtime." That is, if there is no requirement that the emloyee must have previously worked a bona fide standard of hours in the day. There is one exception to this: If the contract calls for "clock overtime" and also for overtime pay after a standard number of hours in the day, and if the "clock overtime" normally falls after the employee has already worked the standard hours. In such a case, the overtime pay would be real overtime.

2. Extra pay for work on holidays. This is not overtime pay because holidays do not occur consistently after a specified number of hours are worked or on any fixed day in the week. The extra pay must be included in computing the "regular rate."

(However, pay for a holiday not worked need not be included in the "regular rate" and, of course, can't be offset against any overtime due under the law.)

What about the man who gets paid for a holiday not worked, but is called in to work? According to Mr. Weiss, if he gets straight time or more for working, in addition to the pay he gets for not working, the amount he gets for working must be included in the "regular rate," but what he gets for not working would be excluded.

This is how Mr. Weiss said to compute the "regular rate":

Divide the total compensation for the workweek, minus any true overtime premiums, by the number of hours worked by the man in the week.

Who is covered?

Analyzing coverage of the law on the basis of interpretations and court decisions, Mr. Weiss said:

"General coverage of the wage and hour provisions extends to employees who are engaged in the maintenance, repair, reconstruction, improvement or extension of existing instrumentalities of interstate commerce, or of facilities used in the production of goods for interstate commerce. . . . Construction of homes, apartments, schools and churches, retail and department stores is not covered (by the law).

Samples of "instrumentalities of interstate commerce" covered by the law are: "Highways over which interstate commerce regularly travels, interstate railroad or pipe-line facilities, rivers and harbors facilities, and ships; Airports, too, and other transportation terminals; and interstate telephone and telegraph and electric power facilities."

What are "facilities used in the production of goods for interstate commerce?" Most typical are: "The nation's industrial establishments, such as mining, manufacturing or processing plants."

Employees working on the two types of projects just described are covered by the law if they are engaged in one of five general activities: maintenance, repair, reconstruction, improvement or extension. Note that original construction is not included.

This is the situation in regard to employees engaged in original construction:

1. Generally, they do not come under the law "even if the buildings when completed will be used as instrumentalities of commerce or to produce goods for commerce."

2. "However, employees engaged in the construction of new buildings or other new structures are considered covered when their work constitutes an enlargement or extension of existing productive 'facilities' and 'instrumentalities' of commerce."

The law covers, for instance, "employees engaged in constructing new buildings or structures, foundations for machinery, parking lots, plant and access roads, drainage ditches and so on, which become integral parts of an already existing plant producing goods for commerce." Also: Employees engaged in construction of new facilities to provide electric power and light, gas, water, etc., to existing manufacturers.

NEW SKYSCRAPER—100 Park Avenue, a 36-story office building, will be completed in 1950 at a cost of $20,000,000 in New York City's Grand Central area. George A. Fuller holds the general contract. E. J. Kahn and R. A. Jacobs are architects, Fred N. Severud is structural design consultant, and Jaros, Baum & Bolles are air conditioning consultants.

Many special cases

As to extending, enlarging or improving existing "instrumentalities" of commerce, employees engaged in these operations are covered by the law:

Relocation of roads and bridges which carry interstate traffic; building new telephone facilities to improve the existing system or increase its capacity as an instrumentality of commerce; building new sidewalks and drains along existing highways or railroads; building new signal towers erected for an existing interstate railroad, and construction of channels and berths in navigable portions of water.

Another point: coverage is predicated on the work of the individual employee. You must look at the kind of work he performs. "Thus, those employees who are actually engaged in covered (by the law) construction work on the site would be covered, while those engaged in noncovered construction would not." But coverage is not limited only to those who work on the site. All employees required for the performance of covered construction come under the law.

Employees who order, purchase, receive or unload materials from outside the state come under the law regardless of the type of construction. So do employees who regularly travel across state lines in performing their work, even though it may be in connection with noncovered construction such as home building. The same goes for employees who transport material or equipment across state lines or within the state as part of an interstate movement.

Even when coverage is established on the basis of the above principles, there are exemptions from the law for certain employees. Bulletins explaining these exemptions may be obtained from the wage-hour offices.

French power company asks competitive dam designs

Departments of the United States government have recently received notices from the French company, Electricite de France, seeking competitive designs for a 250-ft. dam on the Durance River from "contractors and consulting engineers of all nations".

Interested parties must submit qualifications and references to a board of competition by January 1. "Applications for registration, to which all documents have to be joined concerning the jobs previously fulfilled by the applicant, specially about dams, may be sent before the first of January, 1949," says the notice, "to:

"Monsieur de President du Jury du Concours de Serre-Poncon, Direction de L'Equipment de L'Electricite de France, 3 Rue de Messine a Paris (8e)."

All information can be had at the above address.

Oscar W. Swenson dies; R. R. builder, contractor

Oscar William Swenson, 83, chairman of the board of Foley Brothers, Inc., contractors, St. Paul, Minn., and Pleasantville, N. Y., and a great railroad builder, died in Mount Kisco, N. Y., Dec. 17.

He was a native of Minnesota and a graduate of Carleton College in that state. In 1888 he entered the employ of Foley Brothers at St. Paul.

Eventually Mr. Swenson became field manager of the firm's major projects, including work in connection with the building of the Canadian National Railway, the Canadian Pacific, the Grand Trunk Pacific and the Algoma Central.

A stockholder and director of Foley Brothers since 1913, Mr. Swenson successively became secretary, treasurer, vice-president, president and chairman. As head of the company he directed construction of many piers in N. Y. City, the foundations for the New Jersey side of the George Washington Bridge, and many industrial projects.

Four large local firms to build UN skyscraper

The 39-story United Nations Secretariat building in New York City will be constructed as a joint venture by George A. Fuller Company, Turner Construction Company, Walsh Construction Company and Slattery Contracting Company.

While the successful lump sum bid has not been made public, it has been estimated cost will total $25,000,000.

Arkansas River compact ends long controversy

A water-rights controversy that began in 1901 was ended on Dec. 14 when representatives of the states of Colorado and Kansas and of the federal government signed the Arkansas River Compact at Denver. The compact provides for apportionment of available water between the two states.

The Arkansas River rises in Colorado (except for one tributary from New Mexico) and flows east across Kansas. Its waters have been diverted in both states for irrigation for over 70 years, and as diversions increased, questions arose as to the rights of irrigators near and below the interstate borders to water originating farther upstream in Colorado.

Litigation growing out of these disputes finally reached the U. S. Supreme Court, which in 1943 refused to approve a master's recommendation for a fixed division of available water between the two states on the ground that there should not be a "judicial imposition of a hard and fast rule" while it was still possible to reach an agreement providing for future mutually acceptable changes as conditions warrant (ENR Dec. 23, 1943, p. 2).

Following the Supreme Court's decision, Congress passed an act consenting to an interstate compact. Both states then named commissioners to negotiate a compact and the President appointed Hans Kramer (brigadier general retired) as the U. S. representative. Negotiations began in January, 1946.

Meanwhile work had been started by the Army Engineers on John Martin reservoir, a combined flood-control and irrigation reservoir on the main stem of the river 58 miles above the interstate boundary. That project now is substantially complete. Of the total reservoir capacity of 700,000 acre-ft., the upper 280,000 is allocated to flood control and the lower 420,000 to water conservation.

Sets reservoir procedure

The compact signed Dec. 14 relates chiefly to the operation of this reservoir, setting forth in detail how the storage and release of water from the "conservation pool" is to be handled. However, the matter of increases in diversions from the river in Colorado below the reservoir also is covered.

Compact provisions do not cover waters brought into the Arkansas River basin from other rivers, and operation of the flood storage pool by the Corps of Engineers is specifically exempted.

Provision is made for creation of an interstate agency known as the Arkansas River Compact Administration to administer the compact. Actual release of water from the John Martin reservoir is to be under the control of the district engineer of the corps.

The compact was signed on Dec. 14 by the commissioners and General Kramer. It must be ratified by the two state legislatures and consented to by Congress before its provisions become effective.

MAJOR MEETINGS

Materials Handling Exposition, Convention Hall, Philadelphia, Pa., Jan. 10-14.

American Society of Photogrammetry, annual meeting, Shoreham Hotel, Washington, D. C., Jan. 12-14.

Associated Equipment Distributors, annual meeting, Stevens Hotel, Chicago, Ill., Jan. 16-20.

American Society of Civil Engineers, annual meeting, Hotel Commodore, New York, N. Y., Jan. 19-21.

Canadian Construction Association, Royal York Hotel, Toronto, Ont., Jan. 23-26.

Concrete Industries Exposition, Cleveland Public Auditorium, Cleveland, Ohio, Jan. 31-Feb. 3.

American Road Builders Association, annual meeting, Willard, Mayflower and Statler Hotels, Washington, D. C., Feb. 7-9.

National Crushed Stone Association, Hotel New Yorker, Feb. 7-9.

National Ready Mixed Concrete Association, 19th annual convention, Hotel New Yorker, New York, N. Y., week of Feb. 14.

National Sand and Gravel Association, 33d annual convention, Hotel New Yorker, New York, N. Y., week of Feb. 14.

National Association of Home Builders, annual convention and exposition, Stevens Hotel, Chicago, Ill., Feb. 20-24.

American Concrete Institute, 45th annual convention, Hotel Pennsylvania, New York, N. Y., Feb. 22-25.

Associated General Contractors of America, 30th annual national convention, Waldorf-Astoria Hotel, New York, N. Y., Feb. 27-March 3.

Association of Highway Officials of the North Atlantic States, 25th annual convention, Hotel Statler, Boston, Mass., March 1-3.

American Concrete Pipe Association, 41st annual convention, Richmond, Va., March 3-6.

New York building codes need revision, Dewey says

Gov. Thomas E. Dewey of New York last week appointed a committee to seek means of eliminating restrictive provisions in municipal building codes.

The governor said that there are 178 municipal codes now in force in the state and no two are alike. Of these, 53 percent are more than 20 years old.

Highway research engineers are urged to translate findings into practice

Chairman of Highway Research Board recommends more emphasis on analysis—New study begun of the economics of heavy truck operations as they affect highway design and construction

Too much emphasis is being placed on the collection of data and not enough attention is being centered on analysis of those data, F. V. Reagel, chairman of the Highway Research Board, told several hundred specialists assembled in Washington for the annual meeting of the Highway Research Board. "We are over long on data and over short on analysis," said Mr. Reagel. "Translating findings into practice should be a major function of the people who participate in the work of the board."

Somewhat similar views were expressed by Raymond L. Zwemer, executive secretary of the National Research Council in his address of welcome. Both Mr. Zwemer and Mr. Reagel spoke at the first general session, which was held on the second day of a four-day meeting that started Dec. 8 (ENR Dec. 16, p. 7).

Truck study begun

At the same session a sound movie was shown of trucks operating on a mountainous section of the Pennsylvania Turnpike and on the heavier grades of the parallel sections of U. S. 30 and 11. The cost of operating these trucks is being carefully compiled as the first step in a study of the economics of truck size and weight being conducted by the Highway Research Board.

Plans for the truck study were summarized by H. S. Fairbank and C. F. Rogers of the Public Roads Administration. The pilot study in Pennsylvania was concerned with a determination of elapsed time, fuel consumption and other operating factors under controlled conditions of truck loading and highway grades. Subsequently the study will be extended to relate these costs to the cost of building highways adequate for heavily loaded trucks.

Also reported at this session was a live-load and impact study on a 110-ft. Warren truss on U. S. 30 near Fort Loudon, Pa. Strain gages used in railway bridges impact studies of the American Railway Engineering Association were loaned for this study. During the tests, readings of 24 strain gages were recorded simultaneously by two oscillographs.

Niel Van Eenam of the PRA staff said that seven vehicles with total loads up to 150,000 lb. and axle loads of 14,000, 18,000 and 22,000 lb. were used. Analysis of the results now is in progress. They indicate that the bottom chords carry less than their design loadings while stresses in upper chords exceed computed stress by as much as 15 percent. Full details are to be reported later.

Pavement obsolescence increases

Studies of the life characteristics of highway surfaces being conducted by the Public Roads Administration show an increase in average age of pavements and a decline in life expectancy, according to Fred B. Farrell and Henry R. Paterick of the PRA staff. These studies show that by 1956 only seven percent of the service life of low-type pavements now in use will be remaining, 26 percent of the intermediate types and 56 percent of the service life of high types. At present, resurfacing is playing an increasing part in extending the life expectancy of highways, as was noted in other paper presented at the meeting.

That some progress is being made in correcting this condition was stated by Ross W. Kruser of the PRA staff in a summary of progress on the current federal-aid highway program. That program was advanced during 1948 at a faster rate in terms of dollar volume than at any time during federal-aid history.

As of Oct. 1, 1948, $961 million of federal-aid work representing 15,049 miles was under construction, contracts for an additional $150,000,000 had been awarded but construction was not yet under way, and plans had been approved by the PRA for an additional $204 million of work. Construction totaling $620,000,000 also had been included in state programs but had yet to be authorized by the PRA. However, while this record is encouraging, Mr. Kruser said that the rate of production is not up to the rate contemplated in the federal-aid highway acts of 1944 and 1948.

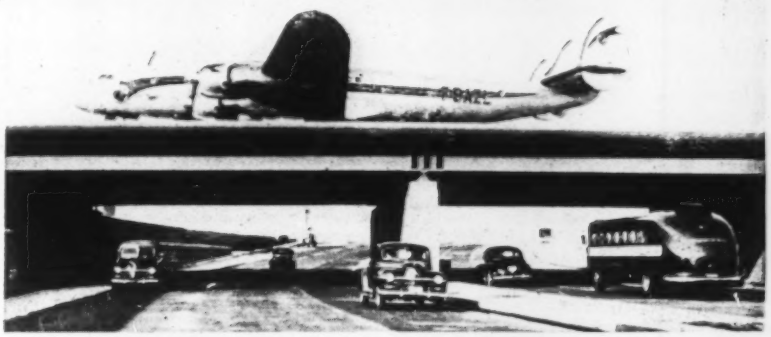
Maintenance costs rise

A continuing steep rise in the trend curve for maintenance costs was reported by the Committee on Maintenance Costs, J. S. Bright, chairman. The maintenance cost index for the latter part of 1948, based on 1935 as 100, will probably reach 190, the committee states, which is 2 percent over the first half of the year.

Several new types of equipment are being developed that should increase the productivity of maintenance forces, the committee added. Two of these will perform part of the surface reconditioning operation. One tears up old surface and pulverizes it, and the other picks up previously scarified material from windrows, pulverizes and cleans it and windrows the clean material for remixing. A small continuous-mix plant has been developed that prepares and loads or stockpiles patching materials without intermediate manual handling. New types of tractor- and truck-loaders also have been placed on the market.

Maintenance personnel

Two reports on maintenance personnel were presented by Rex M. Whitton, chairman of the Joint Maintenance Personnel Committee of the Highway Research Board and the American Association of State Highway Officials. The



TAXIWAY BRIDGES HIGHWAY at New York International Airport. This sub-sea-level underpass was designed to withstand ground water uplift and to carry 150-ton planes above the main auto-entrance to the 4,900-acre airport. (Wide World Photo)

first covered the same ground as was covered in the committee's report to the AASHO meeting in Salt Lake City (ENR Nov 11, p. 86) and repeated the recommendation made at Salt Lake City that a job evaluation study be made by the Highway Research Board or the Public Roads Administration as the basis for better personnel practices in state highway departments.

Mr. Whitton's second report outlined the job evaluation method developed in Missouri and in use there since 1945. It has been found to be a great morale builder.

Subsequently, at the business meeting of the Highway Research Board, the board voted to make the job evaluation study recommended by the joint committee.

Long-range planning studies

Important factors to be considered in studies of future highway needs that have become apparent in the studies made for six states by the Automotive Safety Foundation under the direction of G. Donald Kennedy were summarized by Carl E. Fritts of the foundation staff.

One of the major difficulties faced by state legislatures, Mr. Fritts said, is uncorrelated demands made by separate units of government. Hence, when a highway need study is made it must include a complete appraisal of each major element—state, county and city. The relation of highways to a state's economy also must be determined. This, Mr. Fritts said, is a field in which greater knowledge is urgently needed.

As to future costs, Mr. Fritts said that a "study of past construction price trends and an analysis of economic trends, indicates that today's inflated costs will recede within the next few years."

A plea for closer coordination of urban and rural highway planning was made by Robert B. Mitchell of the Institute of Urban Land Use and Housing Studies, Columbia University. Mr. Mitchell urged state highway officials to accept appointment to city planning committees.

Somewhat similar views were expressed by D. E. Morris, city engineer of Tacoma, and K. B. Rykken, manager of the highway planning survey, Minnesota Department of Highways, in a discussion of the essentials of community, metropolitan and regional planning. Highway engineers, they said, can make a distinct contribution by lending their efforts to the establishment of properly coordinated planning programs. They cautioned against over-emphasis on transportation in the smaller cities to the detriment of other needed facilities.

Discussing the application of planning survey data to highway location, Roy E. Jorgensen, deputy commissioner and chief engineer, Connecticut State Highway Department, stressed the importance of traffic data to the location engineer. He urged that the engineer broaden his approach to the location problem and utilize the full value of the traffic data now available.

To illustrate his thesis, he offered several examples. The first was the New Britain-Hartford highway within the metropolitan area of Connecticut's capital city. Studies for this problem—which came up with an answer quite different from what at first seemed to be the direct, logical solution—made use of traffic flow maps, origin and destination data, and distribution patterns in the city for traffic from several possible expressway locations.

Costs of rights-of-way

Very large savings in the cost of acquiring rights-of-way for freeways through built-up areas can be made by assignment of properly trained men to that work, Frank C. Balfour of the California Division of Highways told one of the general sessions. A major weakness of state highway departments, he said, is inability to appraise the effect of a parallel freeway on local business properties in near-by areas and on adjoining private property. Properties that might appear to suffer on

HIGHWAY ENGINEERS HONORED—Four engineers were honored at the annual meeting of the Highway Research Board for their contributions to highway development. Left to right they are C. R. Hanes, field engineer, Ohio Department of Highways, who received the board's annual award for the best paper presented at the 1947 meeting; Frank H. Jackson, principal engneer of tests, Public Roads Administration, and Charles H. Scholer, professor of applied mechanics, Kansas State College, recipients of the board's new Distinguished Service Award, and second from the right, G. Donald Kennedy, vice-president, Automotive Safety Foundation, recipient of the George S. Bartlett Award, an honor that is sponsored jointly by the Highway Research Board, the American Association of State Highway Officials and the American Road Builders Association. Standing with the award recipients are Thomas H. MacDonald (right) Commissioner of Public Roads, and F. V. Reagel (third from right) research board chairman.

superficial examination frequently will be found to benefit through construction of the freeways. Hence money can be wasted in damage payments as a result of inexperience.

As a step in the direction of meeting this deficiency, the Committee on Roadside Development has a number of studies under way or authorized.

Accidents on divided highways

Efficacy of traffic signals on rural highways was questioned in a paper by George N. Lewis, Jr., director of Maryland's traffic division. On the high-speed four-lane divided road between Baltimore and the Delaware line, signalized intersections seem to be causing accidents rather than preventing them, he said. About half the accidents are rear end collisions.

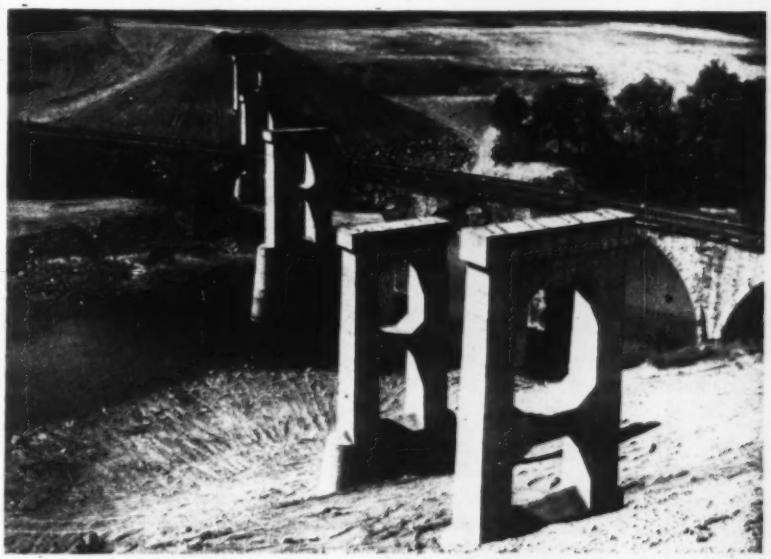
Ralph L. Fisher, design engineer of the New Jersey Highway Department, presented a paper on weaving traffic that indicated the possibilities of "weaving areas" for sorting vehicles traveling in the same direction.

The three main elements of a weaving section, according to his analysis are: (1) the angle of approach—a physical angle of 16 deg. between approach roads, giving an operational angle of approach of about 20 deg., works well at one New Jersey junction; (2) the width—a weaving section should have for the weaving traffic at least one more lane than normally required for the total entering traffic, plus a sufficient number of lanes at each side to carry the through traffic; (3) the length—available data indicate that if the length is more than 900 ft., traffic streams tend to travel side by side, resulting in a forced weaving near the end of the section.

Experience with reflectorized traffic paint has led the Washington State Highway Department to use smaller glass beads than formerly and to mix the beads with the paint just prior to application. These methods offer advantages in economy and service life, as pointed out in a paper by Bailey Tremper and C. E. Minor.

Beads premixed with the paint in a tank on the striping machine are retained more uniformly in the stripe, initially and during service, than when other methods are used. For striping machines not adapted to use of premixed beads, the highway department utilizes the original method of gravity application on the fresh stripe, followed by a second light spray of paint to aid retention during service.

Premixed stripes retain adequate, uniform brightness throughout their life, which is considerably longer than that of similar stripes without beads.



RAISING THE ROADBED—Army Engineers reroute rails at a higher elevation to provide clearance for $33,000,000 Conemaugh reservoir in western Pennsylvania. The reservoir is seventh in a chain of 13 designed to reduce flood dangers at Pittsburgh. The new piers are 100 ft. high. (Wide World Photo)

A new committee on geometric design was organized during the year under the chairmanship of D. W. Loutzenheiser. Among the subjects on its list for early study are: width and cross-sections for divided highways; factors warranting a grade separation; dimensions of commercial vehicles that will effect geometric design; criteria for measuring sight distances in relation to passing; and the relation between design speeds, safe operating speeds and traffic volume.

Air-entrained concrete

Considerable attention was given to air-entrained concrete during the meeting. One paper described a new pressure method for determining the air in fresh concrete which was developed by Bailey Tremper and W. L. Gooding of the Washington State Highway Department. It is believed to be simpler and to require less bulky equipment than earlier pressure methods.

During discussion of this paper the fact was brought out that W. C. Hansen of the Universal Atlas Cement Co. independently had developed a very similar device.

Results of a cooperative study of the effect of air-entrained concrete on bond strength of reinforcing bars made at the University of Illinois and reported by H. W. Russell and E. Hognestad, indicate that for vertically cast bars, the bond strength, when compared to concrete made without air-entraining admixtures, is reduced about 10 percent when 4.5 percent of air is entrained. This reduction corresponds closely to the reduction in compressive strength and modulus of rupture. For horizontally cast bars, little effect was noted up to 4 percent of air. Above that point a progressive reduction in bond strength was observed.

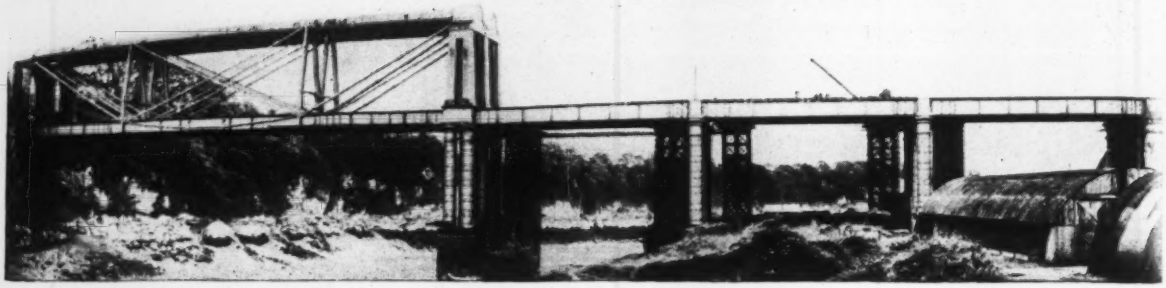
Reinforcing in pavements

A preliminary report on the comprehensive study of reinforced and unreinforced concrete pavement made by the Ohio River Division, U. S. Army Engineers, was given by R. R. Philippe of the division staff. Pavements of several thicknesses were tested under as many as 2,000 repetitions of 150,000 lb. wheel loads, which resulted in failure of many slabs.

Tentative conclusions are that although reinforcing prolongs the service life of pavements after they begin to fail, use of reinforcing instead of a thicker unreinforced slab is not justified from a cost angle.

Officers re-elected

At the board meeting on Dec. 10, F. V. Reagel, engineer of materials, Missouri Highway Commission, was re-elected chairman and R. A. Moyer, research engineer, Institute of Transportation and Traffic Engineering, University of California, was re-elected vice chairman. Named again to the executive committee for three-year terms were Charles M. Upham, engineer director of the American Road Builders Association, and Burton W. Marsh, director of the safety and traffic engineering department, American Automobile Association.



FAMOUS WROUGHT IRON BRIDGE is equipped with falsework so that it can have its . . . .

Approach girders replaced after 96 years service

A bridge repair job, notable both technically and historically, is nearing completion on the rail line between Gloucester, England, and Newport, Wales. The bridge is the one at Chepstow over the River Wye, built in 1852 by the famous British engineer, I. K. Brunel, and the work involves the substitution of steel girders for the original ones in wrought iron, which have been in continuous service for 96 years in the three 100-ft. approach spans.

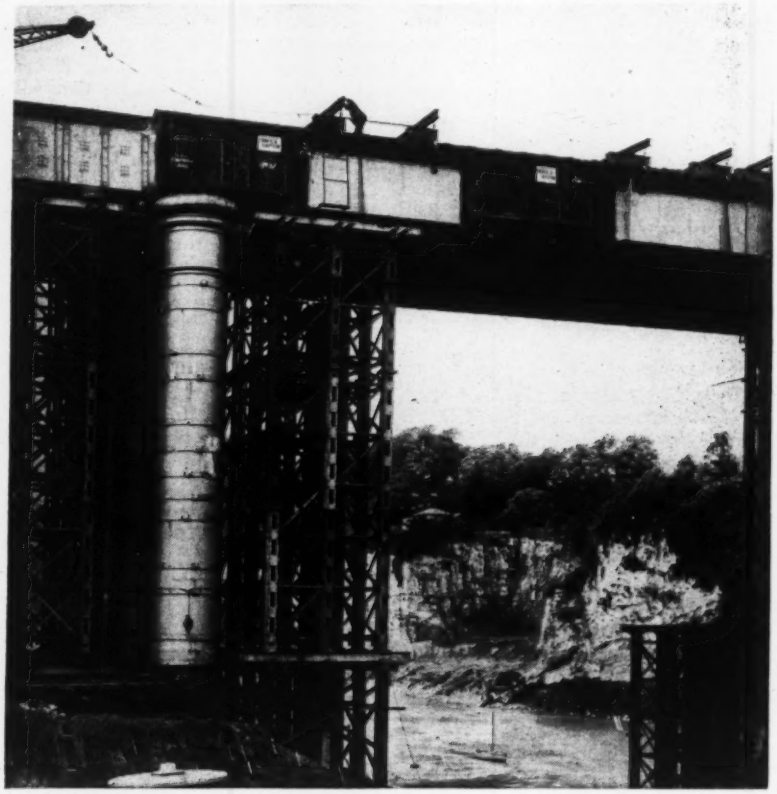
Equally significant is the fact that no repair work is deemed necessary on the 300-ft. wrought iron main span, a queen-post truss with tubular top chords. The same can be said for the foundations, whose construction represented the first major use of pneumatic caissons, antedating the work on the Eads and Brooklyn bridges in the U. S. by a quarter century.

By first supporting the approach spans on falsework towers made from wartime light steel trestling, the repair work could be accomplished by erecting the new girders inside the old ones. Since the bridge consists of two single track structures side by side, work could be done on one while rail traffic used the other.

The new girders, brought out to each span in pairs on flatcars, were lowered to the falsework and skidded laterally to a temporary position at 10½-ft. centers. This left room for a 3-ton traveling crane with which the old deck, stringers and floorbeams were removed. Rails were then laid along the top flanges of the steel girders to provide a runway for twelve traveling beams (photo at right) from which the main girders were slung. These were flame-cut into 15-ft. lengths, which were moved in their slings to a position where they could be picked up by the traveling crane resting in the adjacent, intact span.

After the old girders were removed, the new ones were skidded laterally to their final position, and lowered to bearing on the pier cylinders. The pair of girders on the span adjacent to the river had also to be moved 3½ ft. longitudinally into pockets in the cast iron end posts of the truss.

Removal of the old girders revealed their unusual top flange, which is a triangular box with a curved top plate, and also the light web plates, some of which are only ¼ in. thick. Originally there were only four stiffeners on each girder, although others were added when web buckling appeared as railway loads increased. The weight of each of these wrought iron girders was only 17 tons. The new steel girders are said to weigh more than 30 tons. One reason for this great increase in weight is that the new girders are arranged as simple spans whereas the original ones were continuous over the three 100-ft. openings.



REMOVAL OF OLD GIRDERS was accomplished by slinging them from traveling beams, riding on rails on the new girders. Sections 15 ft. long were then cut off and pulled back to a deck traveler.

Alaska contractors ask AGC to charter chapter

A group of Alaska contractors has asked the Associated General Contractors to grant a charter for an Alaska chapter, with headquarters at Anchorage. Most contractors in the group previously have belonged to the Seattle, Wash., chapter.

R. H. Stock of Stock & Grove, Anchorage, has tentatively been elected president, with D. L. Chaney of F. Birch & Sons Construction Co. as vice-president and William Lofholm, general superintendent for the Morrison-Knudsen Co. in Alaska, as secretary-treasurer.

Serving with them on the board of directors are D. W. Clayton of Lytle & Green Co., M. P. Munter of the M. P. Munter Co., C. William Hufeisen and A. N. Strandberg, superintendent of the Warrack Construction Co.

Other charter members are the Swalling Construction Co., Anchorage; William A. Smith Construction Co., Kansas City, Kansas; and Reed, Dodson & Martin, Fairbanks.

Fishing interests voice ideas on Columbia River

Fishing interests of the Columbia River area, after years of fighting dam construction which they feared would interfere with fish migration, are centering their opposition on proposed projects in the lower river.

T. F. Sandoz of Astoria, Ore., vice-president of the Columbia River Packers association, speaking at a recent meeting of the Pacific Northwest Trade Association, voiced approval of much of the Corps of Engineers program for power development and flood control (ENR Nov. 18, p. 7), including completion of dams already under construction and future construction sufficient to double present power production.

Support was promised for early completion of McNary, Hungry Horse, Libby, Detroit, Glacier View, Sheep Mountain, Meridian and Albeni Falls dams, but still strongly opposed are the lower Snake River and The Dalles dams. Hells Canyon Dam was not opposed.

Reno unions charged with blackmail and extortion

A suit was filed Nov. 28 by Bruce Thompson, assistant U. S. attorney at Reno, Nev., charging the Building Trades Council of that city with conspiracy to blackmail and extort.

The plaintiff, who is building a new residence in Reno, says that the trouble started some time ago when he employed a worker not in good standing with the unions. Representatives of the Building Trades Council, he alleges, told him he must discharge the man. He refused and the union placed pickets around his property, listed him on the "We Do Not Patronize" roster.

Mr. Thompson claims he then received a letter from Ernest M. Reynolds, secretary-treasurer of the council, requesting that he donate $1,000 to the Children's Home in Carson City, and stating that if he would do so he would be put on the union's "Patronize List."

The complaint asks the court to issue a temporary restraining order to prevent the unions from picketing, boycotting or blacklisting the plaintiff.

Desert railroad built to tap iron ore supply

A new, 52-mile, single-track railroad built to take iron ore to the Kaiser steel plant at Fontana, Calif., crosses two major man-made water courses in California's Salton Sea basin. Besides spanning the Coachella Canal and the Metropolitan Water District's Colorado River Aqueduct, the construction involved protection against 125 deg. temperatures and rainfall of cloudburst proportions.

This $3,800,000 construction job will connect the Eagle Mountain iron ore mine with the Southern Pacific mainline near the Salton Sea. More than 25,000,000 tons of 54 percent iron ore have been proved in the deposit and more may be available.

Besides crossing the water courses, major drainage had to be provided in the normally dry washes. For example, Salt Creek is spanned by a 550-ft. wood trestle because federal agencies estimate that runoff could reach 20,000 cfs. Desert cloudbursts in this area seemingly have no respect for tradition and can be expected to occur anywhere along the line. Accordingly, the construction was protected with dikes and some 14,000 lin. ft. of culvert ranging from 30 to 72-in. diameter.

The work involved some 2,000,000 cu.yd. fill and 600,000 cut. Ruling grade is 2 percent for hauling to the mine and 1 percent against load.

The project was designed by Kaiser Engineers, Inc., for the Iron and Steel Division of the Kaiser Co., Inc. J. F. Shea Co. was leading contractor on a $2,300,000 contract that also involved the General Construction Co. and Pacific Bridge Co.

EAGLE MOUNTAIN RAILROAD crosses the Coachella Canal in California's Salton Sea basin by means of a creosoted timber pile trestle.

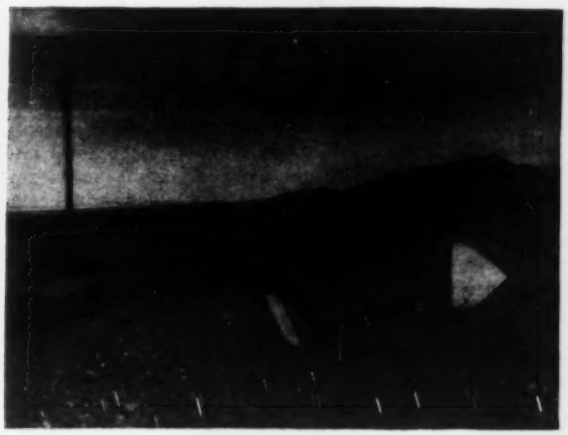
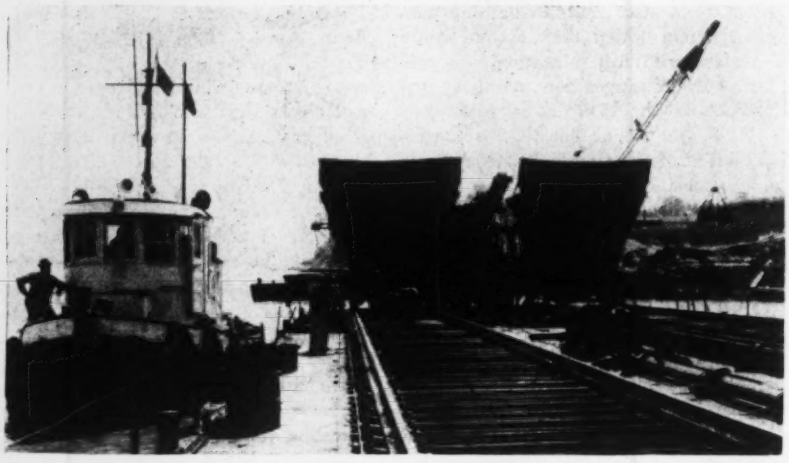


PLATE-GIRDER BRIDGE spans the Colorado River Aqueduct. The aqueduct is in cut-and-cover section and lies just beneath the gravel under the bridge.

RANDOM LINES . . .



. . . In which revetment work on the Mississippi is found to be big business, involving use of such equipment as this great plant for casting and sinking asphalt-block paving.

Bank protection on the Mississippi River is generally thought of as being a continuing battle—with the river usually having the upper hand. However, the incredible scope and magnitude of operations in the Vicksburg District were seen in a recent 50-mile boat trip down river.

Plant and equipment included (1) a 1,300-ft. long, 18-barge tow of bank-grading equipment that moves 1,000,000 cu. yd. of material per month; (2) a sinking plant that will lay 13,700,000 sq. ft. of subaqueous articulated concrete mattress this year—equivalent to covering a 320-acre farm with 3 in. of precast concrete slabs; (3) a complete asphalt plant with 22 pieces of floating equipment producing 120 tons of asphalt per hour for both underwater maintenance and upper bank paving; (4) a huge floating plant that makes and sinks 30,000 one-cubic-foot asphalt blocks per 24-hr. day; and (5) complete living quarters for the 600-man crew of the articulated concrete mattress works. The latter are mounted on 14 barges made up of surplus Navy pontoons, the steel-cube type.

The 225-man bank-grading crew and the 200-man crew for asphalt mixing and underwater paving live in quarter-boats attached to their respective tows. These floating quarters for the workmen are maintained by the Corps of Engineers for two very good reasons. Revetment and maintenance operations are so highly mobile that land-based crews could not keep up with the operations, and (2) floating quarters eliminate absenteeism.

Revetment and other channel stabilization work ordinarily begin in July after the spring floods have passed, and continue until December. Most of the operations are performed on two 10-hr. shifts, six days a week.

U. S. plant and hired labor

Bank preparation and subaqueous revetment work on the lower Mississippi is performed almost entirely by government plant and hired labor—but not by choice. For the past several years the Corps of Engineers has been trying with little success to interest contractors in this phase of revetment work.

Upper bank paving of compacted mass asphalt or riprap is done mostly by contract. Also, articulated concrete mattress slabs for underwater placement are procured entirely by contract at conveniently located casting fields along the river.

One reason why contractors have not become interested in placement of subaqueous revetment is the tremendous initial cost of plant involved. Then, too, this work frequently must be initiated and prosecuted with great dispatch in a race against the destructive scouring action of the river. In such instances the time element of preparing estimates and specifications, and advertising for bids would preclude the possibility of doing the work by contract.

Although time-tested types of revetment are still used in large quantity, new types and methods are constantly being developed. The 20-year old articulated concrete mattress continues to be the best bet for protecting critical locations of flood control structures in the program of bank stabilization authorized by the 78th Congress. The century-old fascine willow mattress is used, however, to considerable extent in certain instances.

For the last two years the Corps of Engineers has had considerable success in repairing underwater breaks in existing revetment by dumping fluid mixes of mass asphalt directly in place. For this they use dredged river sand mixed with 12 to 14 percent of 85- to 100-penetration asphalt (by weight). Mass asphalt paving for upper bank and levee protection above low water usually contains about 7 percent asphalt and 93 percent river sand.

Another method of subaqueous bank protection, contemplated but not yet advanced to the experimenal stage, involves stabilization of the sand bank in place by underwater pressurized treatment with asphalt. This is similar in concept to penetration asphalt construction on highways.

For the past five years the Corps of Engineers also has been repairing underwater breaks in existing revetment with a new type of semi-solidified asphalt block. These blocks, measuring 20x16x5½-in. and containing about 1 cu. ft. of sand-asphalt are cast on a special floating plant and dumped directly into place.

Bank protection engineers

Engineers in charge of the revetment and bank-stabilization plants include: C. J. Swank, bank-grading; Bert Hussey, articulated concrete mattress; and H. L. Brownlee, asphalt mixing plant and asphalt block casting plant. H. R. Andress is in charge of bank stabilization planning for the Mississippi River Commission, and R. H. Haas heads the bank protection branch, both reporting to Maj. Gen. R. W. Crawford, president of the Mississippi River Commission. For the Vicksburg District, Col. R. G. Lovett is district engineer; Wm. C. Harrison is in charge of bank protection, and Key Woods is in charge of bank stabilization planning.

Revetment on the Lower Mississippi truly is big business. But in spite of the tremendous and costly floating plant involved, and the small army of workmen needed to keep the river within its prescribed channel, costs are not excessive. For example, on an average bank revetment job running 5,000 to 10,000 ft. in length, total cost of bank clearing and grading, asphalt upper bank paving, gravel blanket and subaqueous articulated concrete mattress is 35¢ per sq. ft.—J.R.C.

ENGINEERING SCHOOLS

Faculty News

Early next year Prof. A. F. Spilhaus, meteorologist and director of research at New York University, will become dean of the institute of technology at the University of Minnesota, succeeding Samuel C. Lind, retired. Born in Cape Town, Union of South Africa, Professor Spilhaus earned a master of science degree at M.I.T. in 1935. He entered the U. S. Army Air Forces as a captain in 1943 and was discharged in 1946 as a lieutenant colonel.

Russell S. Poor, dean of the graduate school of Alabama Polytechnic Institute, has resigned to join the Institute of Nuclear Studies at Oak Ridge, Tenn., where he will be chairman of the University Relations division.

William Brewster Snow, who received his B.S., in civil engineering at Duke University in 1932 and his M.S. in sanitary engineering from Harvard in 1942, has been added to the faculty of the Duke University school of engineering at Durham, N. C.

Robert H. Culver, a graduate of the University of Florida, has been appointed assistant professor of sanitary engineering in the North Carolina State College school of engineering at Raleigh, N. C. New instructors in engineering mechanics are: Donald E. Davis of Wells, Me., a graduate of the Rensselaer Polytechnic Institute; Gerald E. Hook, of Elon College, N. C., a graduate of N. C. State College; and George W. Middleton, of Warsaw, N. C., a graduate of North Carolina State where he specialized in general engineering.

L. E. Vandergrift has become a research professor in structural engineering at Ohio State University, Columbus. Before entering the teaching field, he had been in heavy construction, a bridge designer, and a contractor operating his own business.

J. Edward Hoffmeister, dean of the College of Arts and Sciences, University of Rochester, N. Y., has announced the creation of an engineering committee to direct the engineering division of the university. Prof. Horace W. Leet heads the committee.

Julian W. Shields has been appointed chairman of the department of civil engineering at the University of Delaware. He has a doctor's degree in civil engineering from Rensselaer Polytechnic Institute, 1937.

Dean A. F. Spilhaus

Frank Charles Mirgain, professor of civil engineering at Rutgers University, has been appointed head of the civil engineering department, Cooper Union School of Engineering, New York City, beginning Feb. 1.

Professor Mirgain has been at Rutgers since 1931. He was resident engineer for construction of the Rutgers stadium during 1937 and 1938, and has been materials engineer for the Indiana State Highway Commission. He is a specialist in municipal engineering and in sanitation. He holds degrees from Purdue and Rutgers universities.

Railroad Laboratory

The Association of American Railroads will erect a railroad laboratory on the campus of the Illinois Institute of Technology, Chicago, at a cost of approximately $600,000. To be erected in the spring of 1949, the building will contain offices for the research staff, a laboratory for mechanical and electrical engineering, packaging and container studios, and a humidity room for controlling testing conditions. It will be erected beside a 600-ft. impact test track.

Wood Box Columns Study

The Research Corporation of New York City has made a grant of $2,000 to the Virginia Polytechnic Institute Wood Research Laboratory, Blacksburg, Va., for a study of wood box columns, which have been in use, although test and design data have not been available. The investigation will determine formulas for their design. With the test data it will be possible to use such columns much more satisfactorily, especially in engineering design with wood. More than 100 tests on full-size wood box columns of various cross-sections, of various plank thicknesses and plank arrangements are being planned, with the planks nailed or nailed and glued. The investigation supervised by E. George Stern, director of the laboratory will be Prof. B. Y. Kinzey of the V.P.I. Department of architectural engineering, assisted by O. J. Blake, fellowship graduate student.

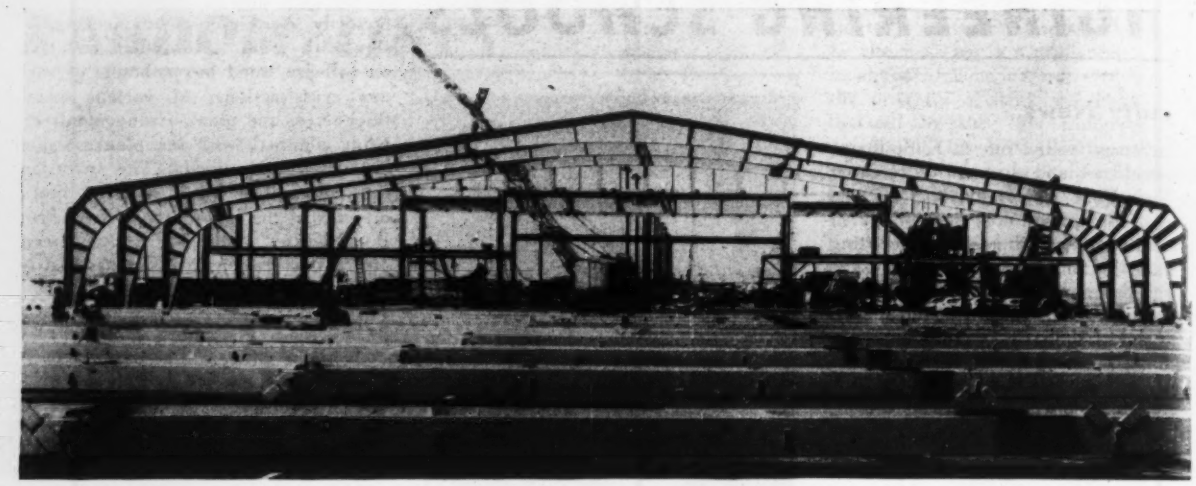
Highway Conference

The second annual Virginia Highway Conference was held at the Virginia Military Institute in Lexington, Nov. 11-13. Jointly sponsored by the State Highway Department and VMI's department of civil engineering, the conference was designed to bring state, city, and county officials together for discussion of mutual road and street problems. Cooperating were the Virginia Road Builders Association, the U. S. Public Roads Administration, the League of Virginia Counties, the League of Virginia Municipalities, the certified county surveyors, local and state planning boards, the division of motor vehicles, the Governor's highway safety committee, and the Virginia state police.

Special Courses

North Texas Agricultural College this fall will conduct two month courses in brick laying for which workers in that area now receive $30 a day and there still are not enough bricklayers. Contractors and builders in that vicinity will award 20 scholarships in bricklaying to young men who have been graduated from high school.

The college of engineering at Northeastern University, Boston, Mass., is offering evening graduate courses, at present comprising part of a curriculum leading to a degree, but designed to meet the need for advanced study by employed engineering personnel who have already completed curricula leading to the bachelor's degree. The courses are: Indeterminate Structures, Cement and Concrete Technology, Theory of Elasticity, Servomechanisms, Pulse Circuits, and Advanced Mathematics for Engineers. A special staff of instructors has been selected for the cement and concrete technology course, including A. T. Goldbeck, engineering director, National Crushed Stone Association; Robert H. Nesbit, chief geologist, Office of the Chief of Engineers, Department of the Army, and Stanton Walker, director of engineering, National Sand and Gravel Association.



THREE 200-FT. SPAN RIGID FRAMES are shown in place with some of the remaining 30 lying in the foreground. Frames will support a transit shed to be used to handle cargo into and out of the Port of Long Beach, Calif.

Rigid Frame Transit Shed Spans 200 Ft.

DESIGN FEATURES of a 1,152-ft. long transit shed recently completed for the Port of Long Beach, Calif., are 32 rigid frames that span the 200-ft. width of the building. This permits a clear working space nearly 1,100 ft. long and almost 200 ft. wide interrupted only by a fire wall at the mid-length. The result is faster loading and unloading of ships.

Erection of the rigid frames was accomplished by the use of three truck-cranes.

Here are the design considerations: Initial cost of a building this wide compares favorably with smaller buildings and operation costs will be greatly decreased.

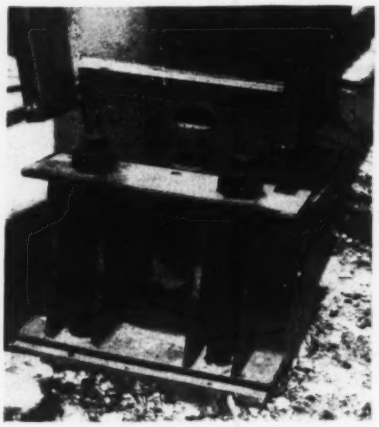
The tendency in rigid frame design has been toward the omission of stiffeners. Some designers believe that the same end can be achieved by making the web plate thicker. This they contend makes a more satisfactory result as they believe the stiffeners actually weaken the web.

However, for long-span rigid frames, the plate thickness would have to be rather great. Thus, in the case of the 200-ft. frames, stiffeners were necessary.

Another disagreement concerning the design of rigid frames centers around the use of radial versus horizontal stiffeners. The designers of the Long Beach structure preferred radial stiffeners because they act in the line of the stresses and are shorter. Since these stiffeners are designed as columns, shorter stiffeners can be smaller in section. Furthermore, radial stiffeners present a neater architectural appearance and intent in design of this transit shed was to achieve neat, simple, effective design.

Frames are all welded

As a further step toward simple and effective design, the rigid frames were all-welded, so that the flange plates, when welded to the web, present a uniform continuous appearance interrupted only by occasional splice-plates. Welding made fabrication simpler, obviating the necessity of punching holes for riveting the stiffeners. It also saved material as the stiffeners could be simple plates rather than angles.



FOUR 1¾-IN. BOLTS hold the base plate of the rigid frames to the footing. Weight is carried by a 6-in. pin.

The welding procedure called for welding the stiffeners to the web before attaching the flanges. Thus no locked-in stresses were induced.

The rigid frames were designed with pin connections assumed at each end. To guarantee such conditions, the base-plate detail includes a 6-in. dia. steel bearing pin through which stresses are transmitted from the frame to the footings.

These base plate assemblies were mounted on the rigid frames prior to erection. Each end of the rigid frame with base plate assembly attached is set on a concrete footing. Four 1¾-in. bolts hold each assembly to the footing. The foundation is on fill.

Some 19 ft. from the water-side footings is a sheetpile retaining wall that restrains the fill. The wharf outside of the transit shed is at the same level as the transit shed floor and is founded on hollow steel piles filled with concrete (*ENR* Sept. 4, 1947, vol. p. 328).

To further resist spreading of the building footings, opposite footings

are connected by sets of 3-in. dia. rods. These rods are encased in concrete as a protective measure and to provide a strut between footings.

The footings are pile supported as the entire structure is founded on a dredged fill. The pile cluster on the water side of the transit shed consists simply of vertical piles. However, on the shore side the cluster includes five vertical piles and four batter piles. These batter piles resist the outward thrust of the entire fill.

Erection is easy

The 200-ft. long frames weigh 42 tons when completely assembled. Three truck-cranes supporting the frames at the center and near the two outside edges were used to set them in place. The erection crew became proficient enough that as many as eight of the frames were set in place in a 6-hr. shift. They were timed in as little as 18 min. from the time the slings were placed around the frame until the slings were loosened. The frames were trucked to the job in five parts, unloaded by truck-crane and laid flat near their final position.

About 70 percent of the welding required to connect the five sections was done before erection. This was enough to hold the frames together during erection and it got away from any overhead welding in cramped positions on the ground.

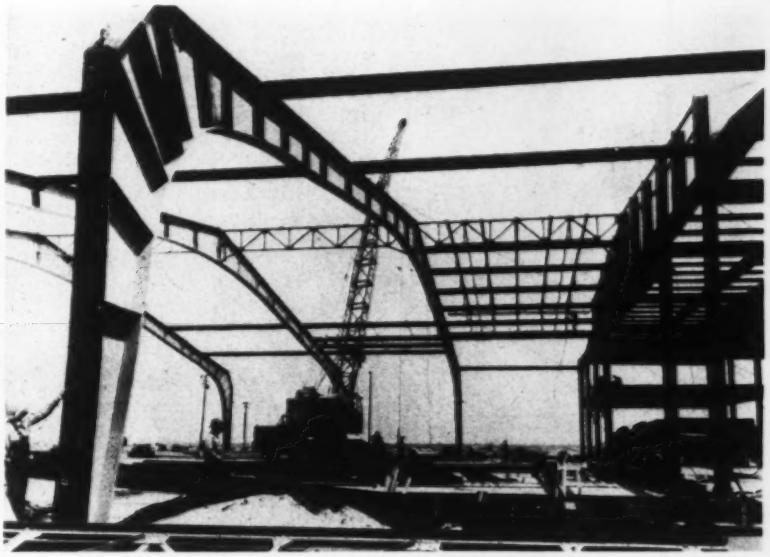
The exterior walls of the shed are of 8- and 10-in. thick poured concrete, placed in the conventional manner. The roof construction is of wood sheathing, treated for fire resistance with chromated zinc chloride. A complete dry-pipe sprinkler system with heat actuating devices and a complete fire alarm and watch system are being installed. Offices and space for utility rooms, special storage and the like are provided for from six to eight tenants.

Favorable cost data

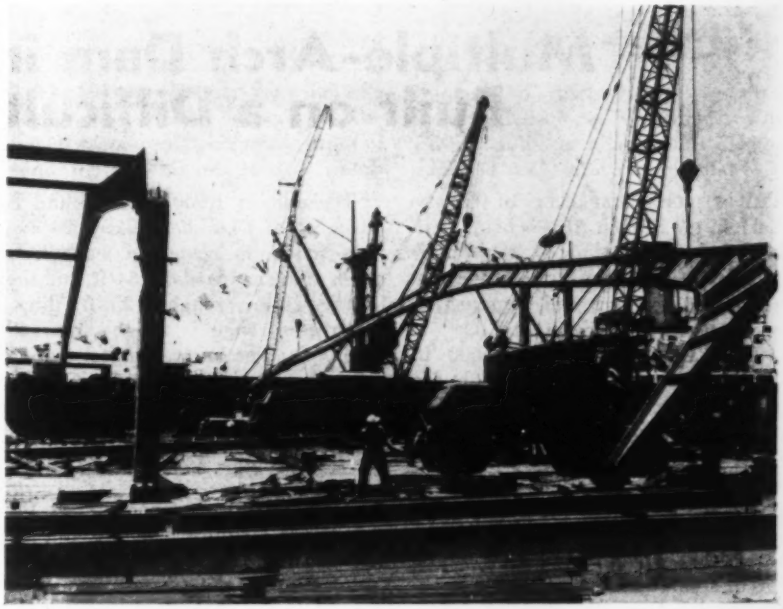
The economic advantage of the large sized transit shed as compared with similar construction for a smaller span is well demonstrated by the unit costs per square foot of this building as compared with two buildings constructed in the preceding year, when unit labor and material costs were lower. The 200-ft. span building cost an average of 22 percent less per square foot than buildings the same in all respects except width —120 ft. instead of 200 ft.

The unit cost of structural steel only, fabricated and erected complete was approximately $211 per net ton, or $2.17 per square foot of floor area. The unit cost of the completed structure including steelwork, but exclusive only of certain limited underground work and footings, was $6.15 per square foot of floor area.

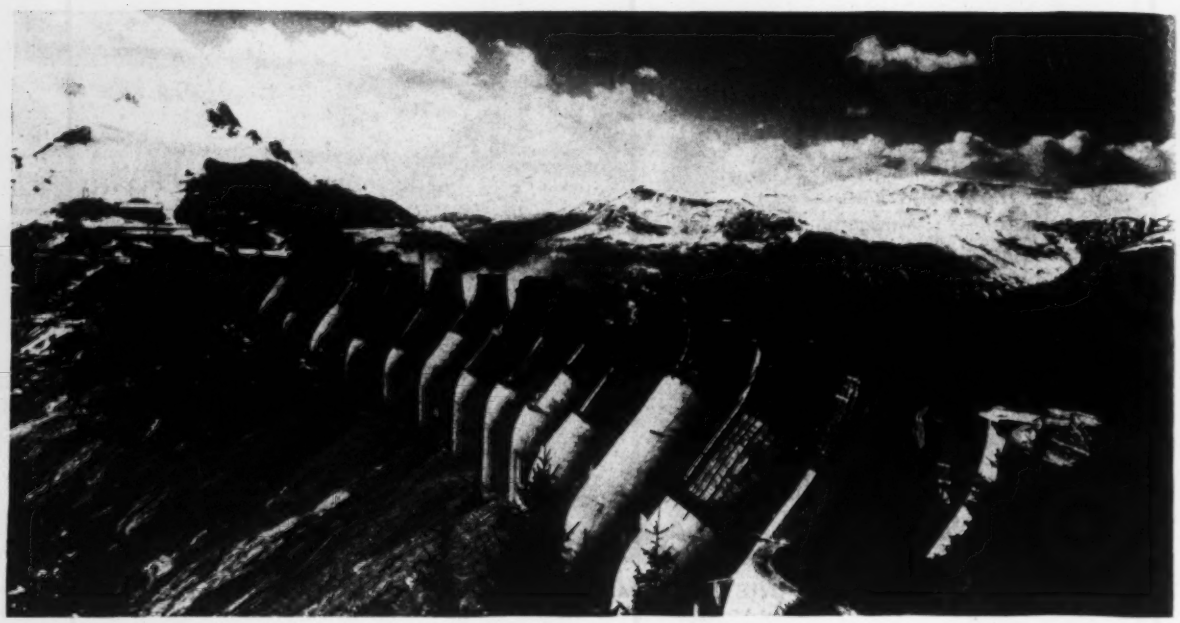
E. J. Amar is port manager of the Port of Long Beach and the engineering work was under the general supervision of R. R. Shoemaker, chief harbor engineer. Structural design was under the direction of R. D. Sandham, assistant harbor engineer. The frames were fabricated by the Pacific Iron & Steel Co.



THE LONG SPAN, RIGID FRAMES feature simple, clean-cut lines for better architectural effect. Walls will be reinforced concrete because of fire-resistant qualities and the roof will be treated wood sheathing.



THREE TRUCK CRANES put the frames in place. As many as eight frames were erected in a 6-hr. shift. Most of the welding was done before erection.



USE OF A MULTIPLE-ARCH STRUCTURE was largely dictated by the narrowness of the ledge on which it had to be set.

Multiple-Arch Dam in France Built on a Difficult Site

THE STORAGE CAPACITY of Girotte Lake in the French Alps is being doubled by construction of a multiple-arch dam along a narrow ridge that put unusual design and construction problems up to the designers.

Lake Girotte, which is 5,600 ft. above sea level, feeds seven hydro plants with a combined annual output of 100 million kwh. Doubling the natural capacity—bringing it up to 40,000 acre-ft.—would double the output of the plants below, but examination of the area revealed that a dam to do that would have to be set on top of a narrow ridge of rock separating the lake from the Bellville valley. This ridge was found to be so narrow and the rock was of such uncertain character as to preclude the use of a simple gravity-type structure. Also access to the ridge from the valley 1,650 ft. below was so difficult as to add materially to the cost of each yard of concrete that had to be transported to the dam site.

Construction of the dam was begun in 1942. War, and lack of materials and labor delayed completion until this year.

The dam is 1,600 ft. long and is made up of 18 arches, spaced 24 meters center to center of buttresses. Each arch span is about 54 ft. and the buttresses are roughly 25 ft. thick. Buttresses range in height from 49 to 114 ft. The lower, vertical section of each arch is 2 m. thick (6.5 ft.) and the upper part is 1.7 m. thick. No reinforcing was used.

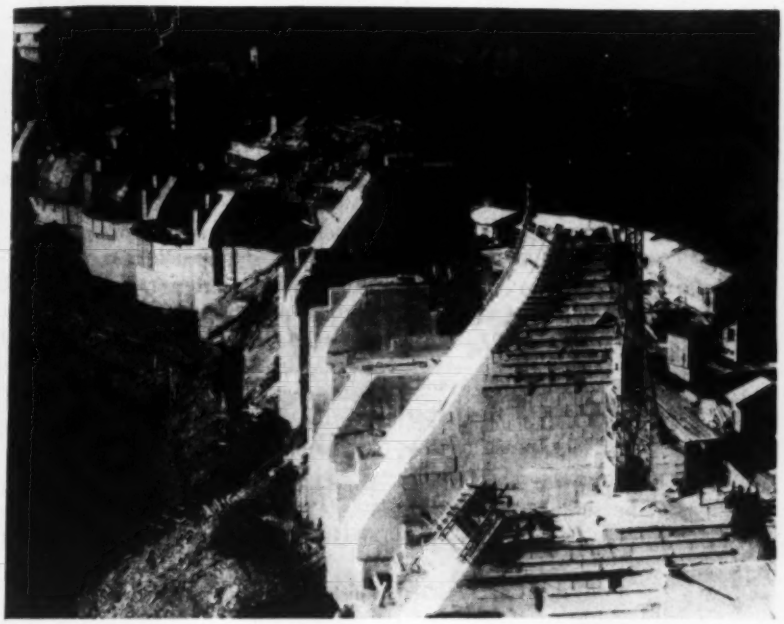
Arches act independently

Each arch is independent of the others for stability, and the unusual form of its load-bearing face was developed to get the greatest amount of beneficial use of the hydrostatic pressure. With the dam built to its present height, all thrust is carried down through the buttresses in such a way as to make the dam safe against overturning. However, as the overturning component will be increased by the proposed future 11-meter increase in height, shafts have been formed down through each buttress to permit prestressed cable anchors for the top section to be sunk deep into the underlying rock, following a method developed by A. Coyne, a well-known French engineer, and already used on dams in France and North Africa.

The complicated curves of the arches were built with movable steel forms supported on steel centering, which proved to be quite satisfactory. Most of the plane surfaces on each side of the buttresses were formed with precast slabs 39x55 in. in area, which had V-shaped grooved edges that provided enough interlock to keep the slabs in good alignment. Horizontal wales anchored by wires through the slab joints provided support against movement while concrete was being placed. Wooden forms were used for the irregular areas at the corners of the buttresses.

All equipment and supplies, including food for the workmen and concrete for the dam were transported to the site by aerial cableways from Belleville, 1,650 ft. below. Concrete transported in this way amounted to 156,000 cu. yd.

Work was carried on through the winter months although the temperature frequently went to 20 deg. below zero. Because of the low temperature to which the concrete will be exposed,



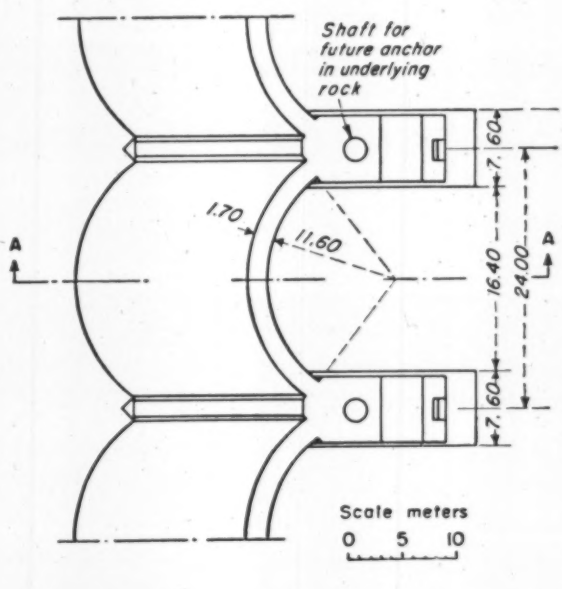
PRECAST CONCRETE SLABS were used extensively as side forms for vertical faces of the massive buttresses.

STEEL CENTERING and forms permitted adjustment to warped surfaces.

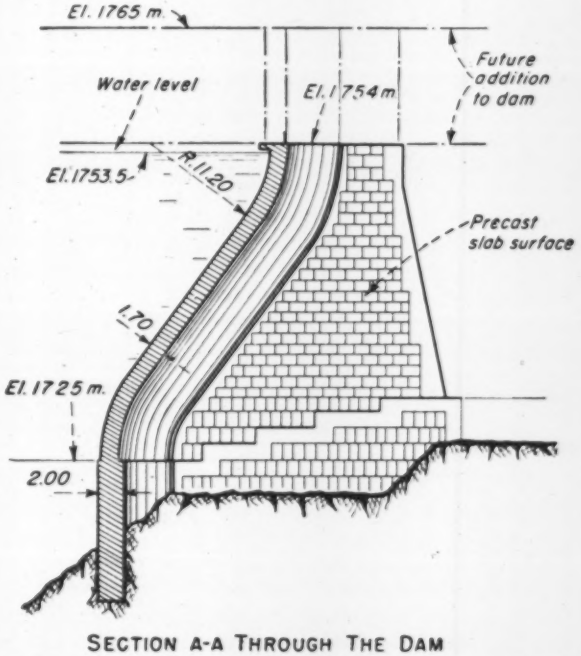
great care was exercised in developing a concrete mix that would be highly resistant to freezing and thawing. Studies made in a laboratory set up at the dam indicated that stone dust (particles less than 0.3 mm. diam.) made the concrete more permeable and therefore subject to frost damage. Therefore, the dust was eliminated from aggregates by washing it during the processing.

The tests also showed the value of a high water-cement ratio. Consequently, some of the middle sizes of sand were eliminated and a water-cement ratio of 1.8 to 2.0 was attained, compared to the more common ratio in France of 1.4 to 1.5. Vibrators were used in this concrete.

The dam was designed by Albert Caquot and was built by Enterprises Metropolitaines et Coloniales, with Emile Jaulin in charge. Mr. Jaulin supplied the information that was used by the Paris office of McGraw-Hill World News in the preparation of this article.



PLAN VIEW OF ONE ELEMENT OF THE DAM



SECTION A-A THROUGH THE DAM

PLAN AND TYPICAL CROSS-SECTION through Girotte Dam. Provision is made in the design for an increase of 11 meters in the height. All dimensions are in meters.

Authoritative Comment on . . .

A New Approach to Pavement Design

Jacob Feld • V. A. Endersby • L. E. McCarty • K. B. Woods • Bernard K. Knight

A design method for flexible pavements that takes into consideration certain physical characteristics of the soil under the pavement and the pavement base as well as the surface loading was described in an article published in the July 8, 1948, issue of *Engineering News-Record*, p. 134. It was written by F. N. Hveem, staff materials and research engineer of the California Division of Highways, who had developed the method as a result of extensive studies on flexible pavements carried on by the Division of Highways over several years.

At Mr. Hveem's suggestion, copies of this article were sent to a number of engineers in other parts of the country who have given considerable attention to the subject of flexible-pavement design. Replies received from some of these men follow:

Correction Factors May Be Needed

Jacob Feld
Consulting Engineer,
New York.

Mr. Hveem's method for pavement design is a reasonable solution of a complicated problem, based on a consideration of three major affecting factors and disregarding all other variables. Whether the other variables are of such minor importance that they can be disregarded can only be determined from correlation between the results of the Hveem solution and the action of the pavements over a period of years.

It is quite likely that correction factors or empirical values for additional variables will be necessary in local areas. For instance, those with heavy frost or with extremes of annual rainfall distribution. In other areas, the three major factors considered in this solution seem to be a sufficient empirical solution.

The problem is not susceptible to an exact solution, until the physical characteristics of the materials involved are completely known and then only if the control on the materials can guarantee perfect results. Such perfection can hardly be expected for the usual type of subgrade (basement) soil and is only approximately possible for sub-base layers.

The cement, asphalt and tar technologists may be able to get consistent results in laboratory tests of concrete made with the respective binders, but the results in the field, under various climatic, labor and equipment conditions, are seldom that uniform. An empirical solution is therefore justified and will probably give more consistent correlation with actual performance of the pavements than a theoretical (and probably more complicated) solution based upon a series of physical characteristics which may not be obtainable in the field.

The three major factors considered are the:

1. Resistance value R of the soil.
2. Traffic load intensity in terms of magnitude and probable occurrence.
3. Ratio of strength of the surface layer to the base material.

The resistance value of the soil, as determined by the author's stabilometer tests is really the reduction of hydrostatic pressure ratio resulting from the internal resistance of the soil. The author's P_h/P_v was given theoretically by Coulomb as $\tan^2 \frac{1}{2}\ (90—\phi)$ and by Rankine as $\frac{1 - \sin \phi}{1 + \sin \phi}$, (which expressions are trigonometrically identical), in terms of ϕ, the angle whose tangent is the coefficient of internal friction.

The writer, in his research on the lateral pressure of sandy soils, found that either expression is a close approximation of the ratio of lateral vertical pressure, if ϕ is taken as the angle of internal resistance of the soil. That value can easily be obtained by a simple shear test, measuring the resistance to motion at the beginning of initial movement. The expression $\frac{1 - \sin \phi}{1 + \sin \phi}$ in the agreed notation of soil mechanics is called K_a. The author has deducted 0.1 from this value, apparently based on empirical considerations, which requires special study for both end conditions, elastically solid and completely liquid soils, or for the soils which come close to these states.

The destructive effect of traffic is taken as the combination of unit wheel pressure on the pavement surface, the square root of the tire contact area and the logarithm of the traffic concentration. As an empirical equivalent is given the California tabular group of factors for wheel-load concentration. This is equivalent to the statement that 100 applications of a given load are only twice as destructive as 10 applications and a single occurrence is disregarded. Statistically this may be correct, but it will not prevent failure of a pavement from a single overloaded truck.

The effect of the base layer and of the surface is assumed merely as so much weight (equivalent base soil in the case of the surface) counterbalancing the lack of tensile strength. Fundamentally, it is equivalent to the increase of internal shear by surcharge. Simple shear in a body is pictured in the theory of elasticity as the combination of equal compression and tension stresses acting at right angles. Failure in shear in granular soils results when the tensile resistance is overcome. Loading imposes compression which must be neutralized, before the tensile resistance of the soil comes into play. If this theory of internal load distribution through base layers is cor-

rect, road construction methods developed to get strength by compaction are wasted energy; all that is required is density, which is more weight in the layer.

The ripples or wrinkles indicated in Mr. Hveem's Fig. 1 are observed in many soil loading tests, even of granular soils. Fehr and Thomas of Penn State College (1912-1915) reported this phenomenon in detail. Basically, it follows from the fact that dilatation, or volume change, in the case of simple shear is zero. The compression strains reduce the volume, and the ripples are the compensating increase in volume.

The empirical expression of the fifth root of the cohesiometer value of the base and equivalent surface material is only susceptible of full scale and actual performance test verification. Since the author is looking for added tension strength or membrane coverage to increase the internal tension resistance, bituminous surfaces should be of greater value than cement concrete of equal thickness. It is doubted whether such is consistent with actual experience.

The summation of the base and surface layers in obtaining a total tension resistance disregards the necessity for equal strains under the respective distributed loads. A rigid surface on a weak base cannot be expected to act as a single structural unit because of the great discrepancy in linear strain under variation of load, temperature and other strain imposing factors. This probably explains the propriety for the strength as well as density requirement in base consolidation.

Mr. Hveem's solution is therefore recommended as a useful tool for physical materials and natural conditions within and closely outside the range of conditions considered in the empirical evaluation of affecting factors. The great deal of work required to obtain the results reported in this article are to be commended, as well as Mr. Hveem's complete discussion of the correlation between his work and results obtained by others.

Amplification of Method Favored

V. A. Endersby
Asphalt Dept., Shell Development Co.
Emeryville, Calif.

The factors making for road deterioration and the corresponding factors of resistance thereto are correctly set forth by Mr. Hveem. The basic principle of design used, which is in accord therewith, is thus equally correct. The debatable ground consists of the validity of the test methods and the numerical value of the constants in the nomograph.

The use of the stabilometer has been somewhat difficult for road engineers in general to evaluate, because its interpretations have been based upon a large number of actual road observations rather than any fundamental mathematical theory. In this respect one has to accept as granted that observation has been competent, and this is true of some other constants used in the theory. I have no difficulty in making the above acceptation, within the approximations described by Mr. Hveem himself. In the nature of things, full evidence may be difficult to give, because intimate road study in the field over 20 years or so, involves a mass of detail rather impractical to either publish or study.

The best evidence, perhaps, is that California highways are of high quality and as compared with roads under similar traffic elsewhere, seem to be of reasonable cost.

Of late, considerable analytic study has been made on the stabilometer test, which may result in the ability to convert its results into fundamental stress units and make it less baffling to the more mathematically minded engineers. Whether this can be done with the cohesiometer test, an equally essential element in the design method, is a question.

Some remarks on the constants used appear to be in order. The "basement soil" (a term preferable to subsoil) is tested under what is presumed to be its pessimum condition as to moisture. There is an unsettled difference of opinion in the country at large as to how far this may lead to over-design, which came out very sharply in discussions on the California Bearing Ratio method developed by O. J. Porter. It is probable that a considerable climatic factor is involved here.

Mr. Hveem's statement that the restraining power of cohesionless base materials is dependent upon weight and not composition, is believed to be correct. So far as this covers the base-soil reaction, the lumping together of all base materials in a single thickness formula is logical.

However, I do not believe it to be completely accepted that the distribution of vertical load through the base to the soil is the same regardless of composition, and this seems implied in the nomograph as given. If there is an important difference, an additional scale would be required.

Tables I and II for computing destructive effect of traffic and equivalent wheel loads seem logical, but the constants 1 to 32, which Mr. Hveem states are "arbitrary", could stand more discussion; though the writer does not doubt that a quasi-geometrical ratio does exist. Also, the correlation of the important cohesiometer factor with the restraining power of the pavement depends, in the case of bituminous materials, on traffic speed. The cohesiometer, as used, appears to have an over-all correlation based upon much empirical data, and thus represents an effective average speed.

It is suggested that the destructive factor might be refined by censuses giving the average speed of traffic loads of various magnitudes. The writer is under the impression that the heavier loads, on the average, travel slower than the lighter; and the higher the speed, the greater the restraining effect of a bituminous pavement. This question may be involved in the destructive factor as given. Factual data on the effect of speed as such is lacking in published research.

Speed also affects the validity of testing soils at high water content; displacement of a saturated soil involves movement of water through capillaries, and thus under high-speed loads, saturated soils even at high static plasticity, may offer considerable tensile strength. In which case the stabilometer test on soils may involve an unestimated factor of safety.

The writer would like to ask whether the nomograph could not be extended to cover pavement thickness; the means of choosing such a

thickness are not given, thickness of pavement and base being lumped together.

The cohesiometer, as the writer has been acquainted with it, uses a standard briquette and does not take thickness into account; if a new form using a variable thickness is referred to in the text, then the design method works toward base thickness, forward from R value, and backward from a pavement thickness chosen by a means not given. If the writer were designing roads, he would give Mr. Hveem's method a tryout without much hesitation, but would first require clarification of this. A very good point in the method is that any test methods which can be correlated with the stabilometer and cohesiometer can be fitted into it. Studies are at present under way which may ultimately enable a number of such correlations.

Further Field Study Recommended

L. E. McCarty
Senior Laboratory Assistant,
Texas Highway Department,
Austin, Texas

Of the three major factors appearing in Mr. Hveem's thickness design chart, viz., (1) traffic index, (2) resistance value, and (3) cohesive (or tensile) strength, the first is derived empirically, being based on a statistical treatment of observed data. Numbers (2) and (3), however have some theoretical basis, and the present discussion will be confined, in the main, to comment on the theoretical implications involved in these two factors.

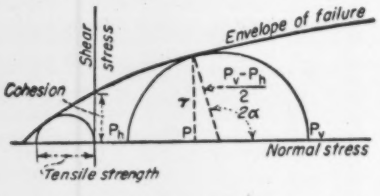
Mr. Hveem's resistance value formula (Equation No. 1 in the article),

$$R = (1 - P_h/P_v)\,100 \qquad (1)$$

may be changed by a simple transformation to the form

$$R = \frac{(P_v - P_h)}{P_v}\,100 \qquad (1')$$

In this form it is evident that the numerator of the ratio $(P_v - P_h)/P_v$ is twice the maximum shear resistance (acting on a plane making 45 deg. with the major principal plane), represented by the diameter of a Mohr circle of failure, as shown in the accompanying diagram.



Since the shear strength τ on the plane of failure,

$$\tau = \frac{P_v - P_h}{2} \sin 2\alpha \qquad (2)$$

is proportional to the maximum shear strength, Equation 1′ shows that the resistance value R is directly proportional to the shear resistance on the surface of failure, in accordance with Mohr's theory of failure in the triaxial test. It is also obvious, both from the Equation 1′ and from the Mohr diagram, that the effective value of R varies inversely with P_v (also with P_h and P). This is the same result stated by the author in par. 3, p. 136, of the article; but the reason for this conclusion seems to be more clearly seen when R is expressed in the form of Equation 1′.

Concerning the mode of "failure" postulated by Mr. Hveem, which assumes an outward and upward flow of subgrade materials due to an applied pavement load which must be resisted by the "surcharge effect" of the pavement and base layers, there is much evidence to support his view besides that contained in the references cited.

In this connection, it would seem that because of the considerable variation usually observed in the ratio P_h/P_v during normal triaxial tests with the Hveem stabilometer on granular-plastic materials having appreciable internal aggregate friction, it is advisable to specify a definite value of one of the principal stresses at which the ratio is to be measured. This requirement may be implied in a statement contained in par. 1, p. 139, of the article, but it is not explicitly stated in any of the several references to the resistance value; and the value to be used in practical applications of the method is not given. Even though the change in stress ratio may not be great over the stress range to which the subsurface material is subjected in the highway, it would be better to specify the proper pressure range, at least, in which the ratio should be evaluated in a test, for the sake of uniformity in procedure and for the benefit of inexperienced operators.

Despite the inherent difficulty of defining a failure point for semi-plastic granular road materials, it seems that some state of incipient failure, such as that existing at a critical density (indicated by an approximately straight portion of the Mohr envelope or the vertical stress vs. lateral stress curve) should be adopted as a common basis for comparison of different materials as to resistance value. This selection would insure the constancy of the stress ratio which is tacitly assumed in the defining formula for resistance value.

Incidentally, it is precisely this quantity, $(P_v - P_h)/P_v$ evaluated at a definite value of P_h, which is evidently related to critical density, that was chosen by Norman W. McLeod as the most significant function of the principal stresses for comparison of airport materials tested for stability in the triaxial test (*Proceeding's*, Second International Conference on Soil Mechanics and Foundation Engineering, 1948, Vol. III).

In discussing the third major factor in the design formula, the writer uses the terms "cohesion" and tensile strength interchangeably throughout the article. For practical purposes this may be approximately correct, but, strictly speaking, they are not equivalent either in nature or magnitude, at least in the Mohr Theory of Failure.

Cohesion is a *shear* stress existing on the surface of failure when the normal stress is zero, while tensile strength is obviously a tensile stress. For all materials obeying "Coulomb's relation", cohesion is half the geometric mean of their tensile and compressive strengths.

In purely cohesive materials, "cohesion" is one-half of the tensile strength (also half the compressive strength) and it always differs from tensile strength in practical cases. Theoretically, it might approach tensile strength in magnitude in a hypothetical case for which the envelope of failure has equal intercepts on both axes in the Mohr diagram, but this case is not even approximated in actual Hveem stabilometer tests on road materials. In fact, it can be shown that it is neither theoretically

nor experimentally possible to extrapolate points of the Mohr envelope of failure into the tension side of the diagram unless the material is at critical density, where it deforms at constant volume.

But, after all, the quantity actually measured with the cohesiometer, properly named the "cohesiometer value," is neither "cohesive strength," as previously defined, nor tensile strength, exactly. It more nearly resembles the fiber tension measured in a modified flexure test on a short beam with end restraints; but, numerically, it is probably very close to the tensile strength which would be obtained experimentally by a straight pull. Moreover, the type of deformation to which the specimen is subjected in the test closely resembles that existing in the flexure to which the top layers are subjected by the downward and upward movement of subsurface material in the road.

However, regardless of the correctness of terminology or of the particular type of stress measured and used in the calculations, the "cohesiometer value" is certainly a function of that indispensable quality of the material in the overlying layers required to prevent failure, thru slab action, as a result of plastic flow of material in the layer considered; and, assuming equal reproducibility and ease of measurement, when the constant factors of proportionality are accurately determined by experiment and it is properly correlated with road performance, it is just as good a measure of that property as is true "cohesion".

This discussion of the "cohesion" factor in terms of a failure theory (Mohr's) and the use of terms and concepts from the Mohr diagram is believed to be justified in view of the theoretical basis already established for the resistance value factor, although Mr. Hveem emphasizes the fact that "the test is not applied according to prevailing notions surrounding the determination of angle of friction and cohesion by tne triaxial shear method".

Due to lack of detail in some parts of the derivations, the reason for using an exponent of $\frac{1}{2}$ for the "cohesion value" is not apparent, but it serves as a sort of weight, probably arrived at partly from experiment and observation and partly from theory, to take care of certain peculiar characteristics possessed by a cohesive material, especially in dynamic loading, which differentiate the resistance it offers to failure from that offered by the frictional type of resistance of the aggregates, characteristics which are extremely difficult to define or evaluate quantitatively.

By way of general summary, the thickness design method developed by Mr. Hveem appears to be comprehensive, logical, and simple and convenient in application. Its practical value is proved to a great extent by the high degree of correlation with large scale test track results, together with the moderately fair agreement shown with a limited number of field observations. Its value is further enhanced by the fact that two of the major factors can be derived from standard theories of failure, and that one of them, the traffic index, is founded on a statistical analysis of a large body of careful observations.

As indicated by the author, the final proof of its practical value must await extensive correlation with a great number of field results, and later revisions, which may consist merely in a redetermination of constants, may be necessary.

Use of Tensile Strength Questioned

Bernard H. Knight
Professor of Highway Engineering,
University of Witwatersrand,
Johannesburg, South Africa

It is perhaps unfortunate to bring in a consideration of tensile strength, as Mr. Hveem does in his article, even if this can be evaluated on the lines being developed by P. J. Rigden of the Road Research Laboratory, Harmondsworth, England, I am doubtful of its utility, especially in view of the probable effects of temperature changes.

The idea of introducing an equivalent hydrostatic pressure, as given in the paper, is a good one.

I should like some correlation of the design chart with some known cases; it may be all right, but without some such correlation, it seems too easy.

I cannot see how rigid and flexible pavements can be treated in the same way, and I am not clear from the paper how it is proposed to differentiate between them.

Some Variables To Be Evaluated

K. B. Woods
Associate Director,
Joint Highway Research Project,
Purdue University.

If the current field program of testing in California, referred to by Mr. Hveem in his article, confirms the general method of attack, a big program of testing and study remains to be completed if the approach is to be used successfully in widely different sections of the country. Even though an attempt is made in the development of the method to evaluate soils, climate, and traffic loads, there are still variables which will need be evaluated.

Important among soil variables is that of the soil profile itself. To illustrate, in certain regions of the country where old glacial materials prevail, well developed and deep soil profiles are encountered. In some materials the profile may consist of one or two feet of rock-flower silt on five to ten feet of very plastic "hard pan", which in turn rests on the unleached parent till. Extensive field survery data have shown that pavement performance varies, in this soil area, depending upon the location of the grade line with respect to the various horizons in the soil profile itself.

Likewise, the climatic influence is important, particularly in regions where frost is an important variable. Widespread failures have been observed which occur during the spring thawing period—that is at the time when the plastic subgrade (Mr. Hveem's basement soil) is thawed to a trench section surrounded on the sides and bottom by frozen soil or by ice. Under these conditions one moderately heavy load is usually sufficient to cause failure of both pavement and base as commonly used on secondary roads.

These illustrations lend support to the idea of developing pavement design methods for climatic-soil-traffic regions—perhaps Mr. Hveem's method can be evaluated and used in several, or perhaps all, of these various local areas.

FIG. 1. IN FLOOD ROUTING BY ELECTRONIC MACHINE operator controls input current to follow inflow hydrograph (right graph). The outflow hydrograph to the left is produced simultaneously.

Electronic Device Speeds Flood Forecasting

R. K. Linsley L. W. Foskett M. A. Kohler

Climatological and Hydrologic Services

U. S. Weather Bureau, Washington, D. C.

TO SAVE THE TIME LOST in computing flood stages for endangered downstream points, the U. S. Weather Bureau whose flood forecasting operations have been described in two previous articles (*ENR*, Nov. 25, and Dec. 9) has invented a machine that eliminates manual computations. The apparatus—named the electronic flood routing machine—automatically produces the hydrograph for the lower end of any selected river reach while the operator traces with a stylus —on the input unit of the electrical hookup—the hydrograph of the expected inflow at the upper end of the reach. Thus the predicted timing, peak, duration and slope of the flood hydrograph for the downstream point become known in a few minutes, and specific warning can be broadcast to all threatened communities in time to permit evacuation of people and protection of goods.

To produce the outflow hydrograph for any selected river reach, it is necessary to have only two factors, in addition to the inflow hydrograph. These factors, K and x, are constants determined from past floods for each river reach. Adjustment of the apparatus to correspond with these constants takes only a few seconds.

Another advantage: The machine will do more accurate routing than can be done by manual methods. It gives a complete graph, rather than a few points for drawing a curve, and the graph shows definitely the peak that might be missed in sketching a curve through points computed manually. The machine's application to flood wave analysis is not limited to large streams; it can be applied to headwater basins by routing effective rainfall directly from the basin.

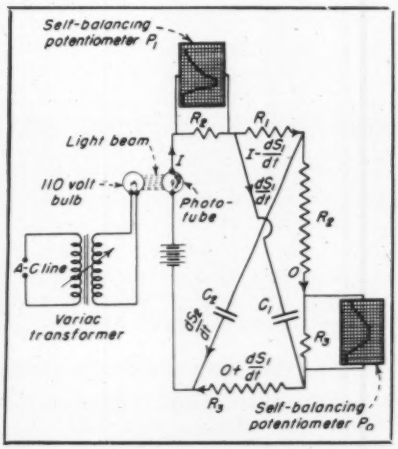


FIG. 2. CIRCUIT DIAGRAM for electronic flood routing machine indicates inflow potentiometer (P_I) and outflow potentiometer (P_O), with condensers and resistances that can be adjusted to correspond with values of K and x for any selected river reach.

Basically, the new machine analyzes flood waves by electrical analogy. By setting the adjustable elements to fit

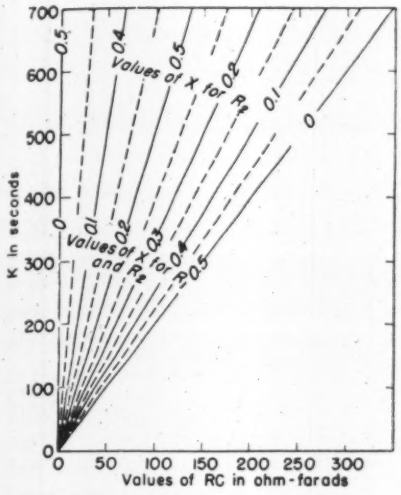


FIG. 3. RESISTANCE VALUES for R_1 and R_2 for specific value of K can be picked off this chart after the corresponding condenser values for C_1 and C_2 have been adopted. R_3 is always equal to R_1.

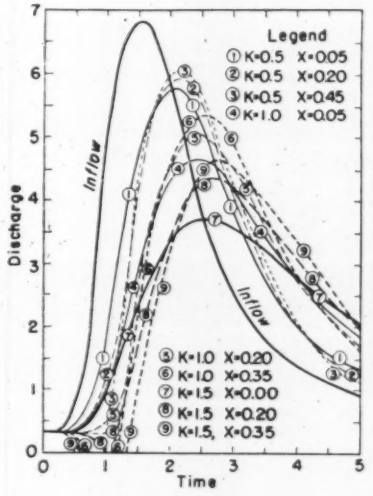


FIG. 4. VARIATIONS in K and x affected the shape of this outflow hydrograph as shown here. From past flood records, the electronic flood routing machine can determine the K and x values by trial for any river reach.

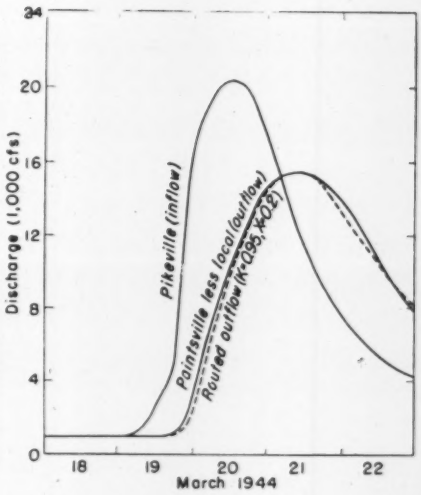


FIG. 5. ROUTED OUTFLOW (broken line) drawn by electronic flood routing machine conforms closely with outflow hydrograph plotted from observed data for Pikeville-Paintsville reach of Levisa Fork, in Kentucky.

the two known constant factors and varying the input current in line with the inflow hydrograph, the operator gets quickly a complete solution to that important problem in hydrology: determination of the changes in the shape of a flood wave as it moves through successive reaches of a river.

This problem has been approached quite generally by the determination of a relation between storage and stage, or flow, which can be used in solving the equation used to express storage:

$$I' - O' = \Delta S \qquad (1)$$

where I' and O' are the average inflow and outflow, respectively, for a period of time Δt, and ΔS is the change in storage during the same interval.

Equation (1) is usually written in the form

$$\left(\frac{I_1 + I_2}{2}\right)\Delta t - \left(\frac{O_1 + O_2}{2}\right)\Delta t = S_2 - S_1 \qquad (2)$$

where the subscripts 1 and 2 refer to the beginning and end of the period Δt, respectively. The solution of Eq. (2) is tedious, particularly if Δt is short, because of the large number of computations and graph readings required. Consequently, numerous efforts have been made to devise simpler solutions.

The analogy between the flow of current in an electrical circuit and the flow of water in a permeable medium in accord with Darcy's Law has long been recognized and has been used in analyses of flow nets under dams and in drainage systems. The analogy is evident from a comparison of the equations

$$i = gE \qquad \text{(electrical)} \qquad (3)$$

$$q = ks \qquad \text{(groundwater)} \qquad (4)$$

where i, E, and g are the electrical current, potential and conductance, and q, k, and s are the discharge per unit area, coefficient of permeability, and slope of the hydraulic gradient, respectively.

The analogy between electrical flow and water flow may be exploited much farther in the solution of streamflow routing problems. This use not only provides a simple, fast and accurate method for routing flood waves, but it also obviates the need for development of flow-storage relations, a time consuming preliminary to most routing operations.

The circuit shown in Fig. 2 represents an arrangement adapted to flood routing. This circuit applies assumptions similar to those used in the so-called "Muskingum method" of routing [O. E. Meinzer "Hydrology", 1st ed., pp. 564-567, McGraw-Hill, New York, 1942]. Storage is assumed to be a function of weighted inflow and outflow, i.e.,

$$S = K[xI + (1 - x)O] \qquad (5)$$

where K is a storage factor with the dimension of time, and x is a weighting factor representing the relative importance of I in controlling storage in the reach.

The current flowing into a condenser is equal to the time rate of change of charge S on the condenser (dS/dt). Hence, with a given inflow current I and outflow O as measured by the potentiometers P_I and P_O, the currents in the various portions of the circuit are as shown in the diagram, e.g., the current through the resistance R_1 is $I - dS_1/dt$. The resistances R_4 and R_5 across the potentiometers are extremely small as compared to R_1, R_2, and R_3, and can be neglected. The total charge on the condensers C_1 and C_2 at any time depends on the potential drop across them, i.e.,

$$S_1 = \left[\left(I - \frac{dS_1}{dt}\right)R_1 + OR_2\right]C_1 \qquad (6)$$

and

$$S_2 = \left[\left(O + \frac{dS_1}{dt}\right)R_3 + OR_2\right]C_2 \qquad (7)$$

Combining Eqs. (6) and (7) and simplifying, the total storage in the circuit is

$$S = IR_1C_1 + OR_2C_1 + OR_3C_2 + OR_2C_2 - C_1R_1\frac{dS_1}{dt} + C_2R_3\frac{dS_1}{dt} \qquad (8)$$

If the resistances R_1 and R_3 are equal and the capacity of the two condensers is the same, then

$$C_1R_1 = C_2R_2 \qquad (9)$$

and Eq. (8) can be reduced to

$$S = R_1C_1(I + O) + 2OR_2C_1 \qquad (10)$$

In the steady state ($I = O$) Eq. (5) reduces to

$$S = KI \tag{11}$$

and Eq. (10) becomes

$$S = 2(R_1C_1 + R_2C_1)I \tag{12}$$

from which the storage constant K is

$$K = 2(R_1C_1 + R_2C_1) \tag{13}$$

Substituting this value of K in Eq. (5), and letting S equal that given by Eq. (10),

$$R_1C_1(I + O) + 2OR_2C_1 = 2(R_1C_1 + R_2C_1)[xI + (1 - x)O] \tag{14}$$

which solved for x, becomes

$$x = \frac{R_1C_1}{2(R_1C_1 + R_2C_1)} \tag{15}$$

Thus, it is seen that the electrical storage in the circuit of Fig. 2 is analogous to the channel storage assumed in the Muskingum routing method (Eq. 5) when $C_1 = C_2$ and $R_1 = R_3$. The rates at which electrical energy is being stored in C_1 and C_2 are proportional to the inflow and outflow currents, respectively, and

$$O = I - \frac{dS_1}{dt} - \frac{dS_2}{dt} = I - \frac{dS}{dt} \tag{16}$$

which is the basic differential storage equation. In other words, the current O at P_o can be made to simulate the outflow hydrograph from a reach by adjusting the condensers and resistances in accord with the proper values of K and x, and varying the inflow current in such a manner that the time graph of I corresponds to the inflow hydrograph to the same reach.

In the pilot model now being tested, two recording potentiometers are inserted in the circuit across 200-ohm resistors. The inflow current is controlled by varying the voltage on a lamp which in turn varies the light intensity falling on the phototube and thus the current. The use of a "constant current" source such as the phototube eliminates the need for consideration of circuit impedance or resistance.

In operation, the inflow hydrograph is plotted on the chart of potentiometer P_I and the inflow current is varied so that the potentiometer pen follows this plotted graph. The resulting outflow graph is automatically traced on the chart of potentiometer Po which moves with the same speed as the chart on the inflow potentiometer.

Values of K and x for the circuit can be computed from Eqs. 13 and 15. The constant x is dimensionless, but K has the dimension of time (seconds using ohms and farads) and hence the selection of the proper K is influenced by the paper speed and time scale selected for the inflow graph. Figure 3 shows the relation between x, K in seconds, and the products R_1C and R_2C. Once a value of C is adopted, all changes can be accomplished by varying R_1, R_2, and R_3. By the nature of the circuit R_1 must always equal R_3.

The effect of variations in K and x on hydrograph shape are shown in Fig. 4 where outflow hydrographs resulting from a given inflow and various combinations of K and x are shown. It is interesting to note that with high values of x the outflow actually decreases immediately after the inflow begins to rise. Since high values of x associate a high proportion of storage with inflow, it is apparent that when x is too large a rapid rise would result in too great a value for dS/dt, and a consequent decrease in O to keep Eq. 16 in balance.

Constants easily determined

A great advantage of the electronic routing machine is the ease with which values of K and x can be determined by trial. If a run is made with estimated values of K and x, comparison of the observed and computed hydrographs with Fig. 4 will show the adjustments necessary to obtain better agreement. A test of the adopted values of K and x on other hydrographs for the same reach will provide final confirmation of the constants or data upon which to base a selection of the best average values for the reach.

Experience has shown that K may be taken equal to the average time differences between crests (in seconds corresponding to plotting scale and chart speed) with sufficient accuracy for preliminary trials. The dimensionless ratio x can be estimated from the relative slopes of the two hydrographs as they cross. Differentiating Eq. 5 and combining with Eq. 16,

$$\frac{dS}{dt} = Kx\frac{dI}{dt} + (1 - x)K\frac{dO}{dt} = \underset{I - O}{} \tag{17}$$

and when $I = O$, i.e., when the hydrographs cross,

$$x\frac{dI}{dt} = (x - 1)\frac{dO}{dt} \tag{18}$$

or

$$x = \frac{\frac{dO}{dt}}{\frac{dO}{dt} - \frac{dI}{dt}} \tag{19}$$

Thus, the value of x can be estimated from Eq. 19 or both K and x can be obtained by applying Eq. 17 at any two times along the hydrographs and solving the two resulting equations simultaneously.

The limiting values of x for natural reaches have generally been considered to be zero and 0.5. An examination of Eq. 19 will show that this assumption precludes the possibility of the downstream peak occurring prior to the time when the inflow has receded to a value equal to or less than outflow, due allowance being made for local inflow. In other words, the peak outflow must occur at or after the time when two hydrographs cross.

As mentioned previously, a pilot model of the routing machine has been assembled and numerous tests made (Fig. 5). The accuracy of the results is considered very good, and it has been found that proper values of K and x can be readily determined in a minimum of time.

As the pilot model was assembled from available standard parts, the potentialities of such an instrument are still undetermined to some extent. For instance, there are several possible methods by which the inflow graph can be automatically converted to inflow current. Also, circuits can be combined so that the inflow from two or more upstream sources with different values of K and x can be routed simultaneously to produce the outflow hydrograph. This offers a wide range of possibilities in the treatment of tributary inflow.

Attempts to route runoff increments through storage to derive the outflow graph for basins up to 15,000 square miles have been uniformly successful, using both a single inflow graph and also subdividing the area and using different values of K and x for each subdivision. These and other possibilities are being investigated as the next step in the development of a routing machine which is inexpensive, accurate, and practical for preparing flood forecasts.

Structural Design Practice For Earthquake Resistance

Editor's Note—To summarize practice in California for the design of structures to resist earthquakes, this presentation was adopted by the convention of the Structural Engineers Association of California recently held at Santa Barbara, Calif. This statement includes only the fundamental phases of this subject wherein there is agreement. Controversial questions are indicated in the accompanying discussion of the paper, also presented at the convention. Solutions to some of these problems could well result in important additions to the earthquake provisions of building codes.

ALTHOUGH the principal features of the earthquake problem in engineering are well understood, engineers must continue studies to improve design methods since there are yet unsolved problems in connection with the design of structures to resist seismic forces.

During an earthquake, the surface of the ground undergoes irregular, oscillatory displacements characterized by relatively large accelerations. Structures resting upon the ground are thus subjected to vibratory excitations, and they respond according to their size, shape, mass, rigidity, damping characteristics, and the properties of the soil upon which they rest. The earthquake waves originating in the ground induce in the structure inertia forces, and these inertia forces are proportional to mass, as contrasted with wind forces which are proportional to exposed areas. Although the problem outlined in the foregoing is in principle solvable for the dynamic stresses, the complete solution has not been obtained because of the large number of variables involved.

The complexity of this problem introduces certain special features in design methods. Since it is not possible to predict the intensity, duration, and character of a future earthquake and since at present it is not possible to predict accurately all of the dynamic properties of a structure before it is built, it is evident that the design cannot be made to depend upon a complete dynamic stress analysis. Of necessity the design must be based upon a system of equivalent loads (analagous to the loads used for impact on bridges) that will produce maximum stresses of the same order of magnitude as can be expected from typical earthquakes.

From the nature of the earthquake problem, it is evident that an exactly equivalent system of loads cannot be established. Therefore, a method of design based upon a postulated equivalent load must be supplemented with design rules and procedures which make up for any deficiencies in the assumed loads. In this case the procedure for analysis and design cannot be deduced simply from engineering principles, for there will be elements in the design that must be decided on the basis of judgment, experience, and standard practice, and the design becomes in practice an art as well as a science. This art is best acquired through field observation and study of earthquake damage.

Although there are differences among engineers regarding details, there is general agreement regarding principles of stress analysis and design. This presentation is intended to outline present California practice in the design of earthquake-resistant buildings in its broader aspects and is not a presentation of design details. To best explain the earthquake provisions of building codes, it is confined to basic statements to be of maximum benefit to those who study such provisions for the first time.

Loading for seismic design

The seismic load is applied as a horizontal force at each floor level. This force is based upon the dead load of the floor and tributary walls and the live load carried by the floor; its magnitude is equal to the dead load plus a portion of the live load, all multiplied by a coefficient known as the "seismic factor." This factor is set forth in building codes, and it varies with the code and with the occupancy of the building, and in some cases with the geographical location, the type of soil, and the number of stories in the building. Such factors have been established from time to time by groups of seismologists, engineers, and building officials, who have weighed the evidence of recorded accelerations, dynamic behavior of buildings, observed damage in previous earthquakes, the frequency of destructive earthquakes, and the additional cost of providing protection. None of the factors in general use guarantee complete freedom from damage in the event of a major earthquake, but they do provide that degree of protection which their sponsors considered to be economically justified.

The more recent codes recognize the dynamic properties of tall buildings by varying the factor inversely with the number of stories in the building. Most codes apply higher factors to such elements as filler walls, cantilever walls, and towers. These have been observed to be particularly susceptible to damage. Higher factors are also applied where failure would involve a special hazard to life or property. The higher factors specified for parts of a structure are used only to design those parts and their connections and are not used in the design of the structure as a whole.

Distribution of loads

In general, the seismic load is applied parallel to each of the two principal axes of the building, but these two conditions are not considered to act simultaneously. This load is applied to the horizontal distributing elements, such as floor slabs, diagonally sheathed floors or roofs, bond beams, or horizontal trusses. These elements react upon the vertical resisting elements, such as rigid frames, braced frames, or shear walls. The distribution of the lateral load to the vertical resisting elements is dependent upon the relative rigidity of the horizontal and vertical elements, the relative rigidity of the vertical elements with respect to each other, and the location of the center of rigidity with respect to the center of mass.

Two extreme opposite conditions

are possible: First, the horizontal elements may be very flexible compared to the vertical elements with the vertical element assumed to take the tributary load. Second, the horizontal element, such as a concrete floor, may be very rigid compared to the vertical elements. In this case the vertical elements are assumed to carry loads proportional to their relative rigidities.

Further, when the center of rigidity does not coincide with the center of mass, torisonal effects must be considered. Consultation between the architect and engineer at the time the first rough sketches are being made will result in locating resisting elements as favorably as possible consistent with the function of the building.

Many buildings fall between the two extremes of stiffness noted above and cannot, in general, be analyzed rigorously in the time available to the practicing engineer. For these cases the engineer may make conservative assumptions which will bring the mathematical analysis within tolerable time limits.

Design procedure

After determination of the forces transmitted to the various resisting elements, these elements are analyzed and designed by the principles of mechanics or by any of the applicable approximate methods in general use. A one-third increase of allowable stresses for combined vertical and horizontal forces is customary. Wind and earthquake loads are not assumed to occur simultaneously.

Observed effects in damaging earthquakes have shown that often structures have failed first in the details. Therefore, most engineers provide, and the better organized building departments require, complete detail sections of the work. Typical details are provided that are applicable to the situation and do not require the builder to exercise "engineering judgment."

It is this requirement to provide detail information on the design drawings, as well as the requirement to provide a complete set of computations for the entire structure before issuance of a building permit, in which California practice appears to differ from that commercially acceptable in some other areas. It is considered good practice to include sketches and a statement giving the general arrangement of assumed lateral force resisting elements, except where the building is so simple as to make this obvious.

Discussion: Unsolved Problems

John A. Blume
Consulting Structural Engineer
San Francisco, Calif.

It is significant that the committee preparing this paper was forced to eliminate practically all figures, percentages, and other definite statements to have a paper that could be supported by the many members of the Structural Engineers Association of California. In other words, elimination was resorted to where compromise was considered impossible. This lack of complete agreement by men continually engaged in seismic design is an indication of the problems yet to be solved.

These problems are illustrated by the fact that entirely satisfactory conclusions have not been reached on the following questions:

(1) Design of all structures on the basis of a percentage of weight as an assumed lateral force.

(2) The percentages required by various codes for such forces.

(3) The way such percentages are reduced according to the number of stories for high buildings, regardless of width or other dynamic characteristics.

(4) The amount of live load required by various codes to be included in the weight used in seismic computations.

(5) The variation of coefficients for soft ground conditions.

(6) The amount of stress increase permitted under earthquake motion.

(7) The handling of the overturning (cantilever) moment problem for high buildings or units thereof which act structurally for many stories.

(8) Design practice does not adequately differentiate between flexible and rigid structures.

(9) The definition of a diaphragm as a horizontal distributing element.

These are examples of why we should not be too complacent about our present practice but should strive to further our knowledge and improve our earthquake design methods. Disagreement over these points is due to differences about basic facts.

Thus we come to the essential function of the recently established Earthquake Engineering Research Institute (*ENR* March 11, 1948, vol. p. 389): To ascertain the basic facts about this extremely complicated problem so engineers can agree on the most economical earthquake design practice consistent with safety.

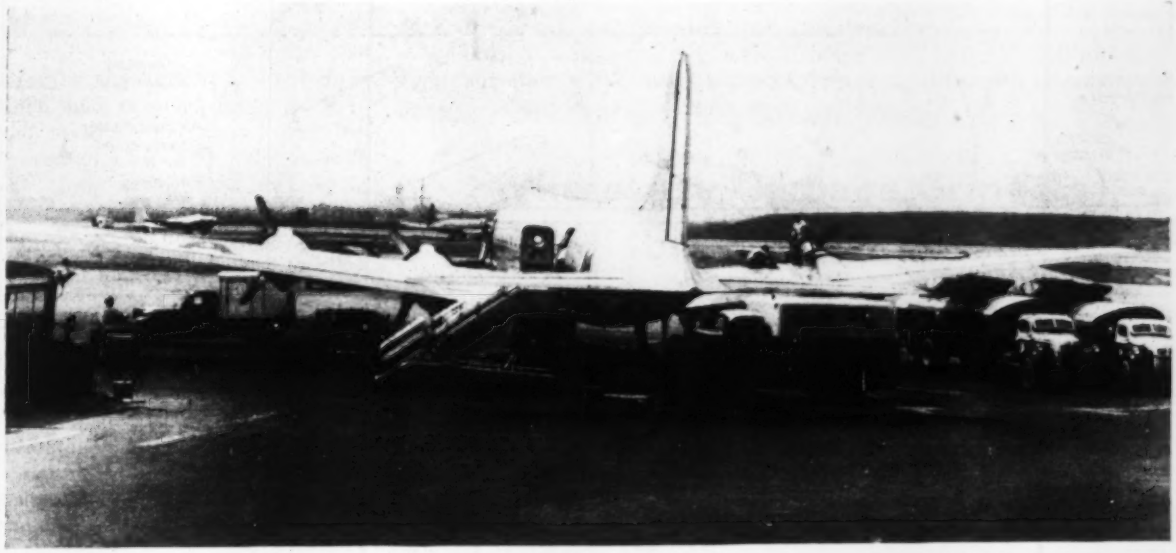
The institute is intended to constitute a continuing agency which can devote the necessary personnel and facilities to stimulate public interest to carry on essential research, and to disseminate information for the advancement of earthquake-resistant design and the public welfare. All work will be conducted on a scientific basis to learn the facts about anything involved in the reaction of earthquakes on man-made structures that may lead to practical results in design and construction.

Bulletin Lists Remedies for Attic Condensation

Insulated attics should be well ventilated, or provided with a vapor barrier in the ceiling to avoid destructive moisture condensation on cold surfaces above the ceiling. This conclusion is presented in an article, "Attic Condensation in Tightly Built Houses," in Technical Bulletin No. 6 of the Housing and Home Finance Agency, Washington, D. C.

Particularly in parts of the United States where winters are severe, condensation difficulties arise from the passage of water vapor from the heated parts of the house into the attic. If water vapor passes through the insulated ceiling in sufficient amounts, and the attic temperature drops low enough, the vapor will condense on roof boards, rafters and other cold surfaces, causing deterioration and rot.

To get reliable data on ventilating openings as commonly installed in well-insulated houses, the Forest Products Laboratory of the U. S. Department of Agriculture, in cooperation with the HHFA, investigated conditions in several houses in Madison, Wis., and conducted controlled experiments. The relative humidity of the heated portion of the house and ventilation of the attic space were shown to be major factors in the control of condensation. It is noteworthy that the greatest amount of condensation and lowest temperature were found to occur in the eave overhang.



Service equipment at larger airports increases necessary apron area and creates congestion that causes high operating costs. These can be reduced by . . .

Putting Airport Utilities Underground

E. R. Trammell
Chief Engineer
Airways Engineering Consultants, Inc.
Washington, D. C.

BECAUSE of congested apron conditions at most large airports it takes about 30 min. to unload and load a passenger plane, service it and make it ready for takeoff. Such a long turn-around time cuts heavily into operating revenue, as may be seen from the fact that cutting the turn-around to 15 min. would add 18 hr. additional flying time per loading position; at 5c per passenger mile this amounts to $1,419,187 per year. And this time saving can be made by a relatively simple engineering design. So worked out by the author in a recent study, it consists in putting all the utilities underground in a tunnel, with surface pits under hinged covers, to supply all services and safety needs.

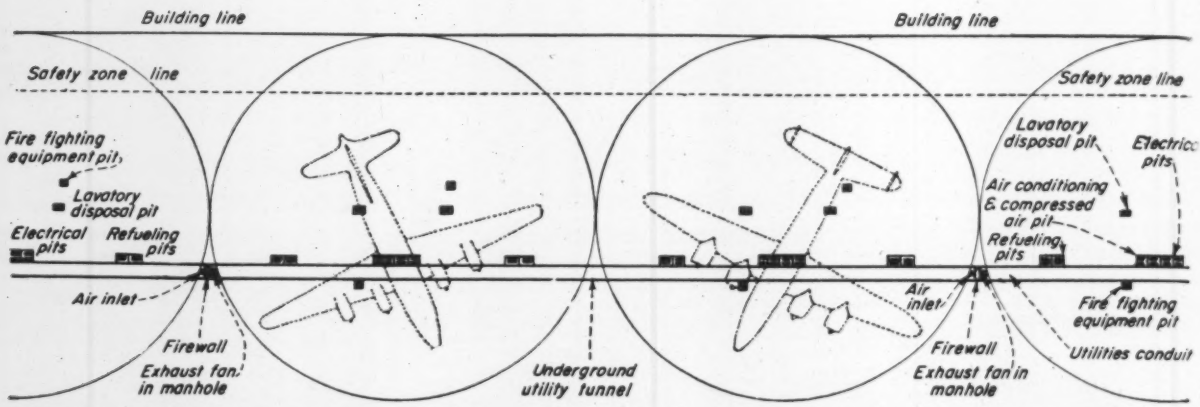
Airport construction costs, too, can be reduced by better apron design. For example a city airport that requires 20 loading positions to take care of its traffic under present apron operating conditions (30 min. on the apron for each aircraft), could cut this number to 10 by reducing this time to 15 min. Then if the width of the apron is 400 ft. and the loading positions are 150 ft. wide, a decrease in required pavement of 66,667 sq. yd. is possible. At $7.00 per sq. yd., the average total cost of apron, this would represent a saving of $466,669 for the city.

It is evident that a considerable amount could be economically spent in improving apron utility services. For each plane servicing operation, at least one fuel truck, one air-conditioning truck, one waste disposal truck, two fire extinguisher carts, one electric utility cart, two ladders for refueling use, and miscellaneous mechanics' tools must be on hand. The only place to keep such equipment is along the edge of the apron. Every time a plane docks, the ground crews must move this equipment out to the plane—and then back after servicing. To operate this equipment requires eight men for each plane serviced. It is no wonder that the payroll cost for personnel and charges for insurance are sky-high.

It would be relatively simple to put all these units into an underground utility system that would greatly reduce the time required for apron servicing. One practicable arrangement, shown in the accompanying illustrations, involves a tunnel large enough (6½ ft. in diameter) to admit workmen easily for maintenance and for the addition of new utilities as needed. Above this, the 150-ft.-dia. loading positions have utility outlets grouped for convenient access to the parked planes. The utility connections are installed just below the apron surface in pits with hinged aluminum alloy covers designed to support the heaviest aircraft using the airport.

Location of pit covers

In this design, pits are so located that the landing gear of a parked plane will not rest on any of the pit covers. In addition, they are so located that all utility outlets will be close to their connections in the aircraft. Thus, the electric outlet is almost in the center of the loading position, to be near the electric plug in the bottom of the aircraft frame, between the main landing wheels.



UTILITY TUNNEL UNDER AIRPORT APRON carries all pipes and conduits leading to service pits conveniently located at each plane parking position. Pits have hinged covers over which wheels move without interference.

regardless of the direction in which the plane cabin is turned. Likewise, the refueling pit is close to the fuel tank inlets in the wings, no matter what position the plane takes for parking. There will always be pits containing fire extinguishers on both sides of the plane. In case of a sudden fire, at least one of the pits could be placed in operation quickly. The airconditioning and compressed air pits also are near the center of the loading position, where they will be needed. Air-conditioning may be obtained from individual units at each loading position or from the building airconditioning system.

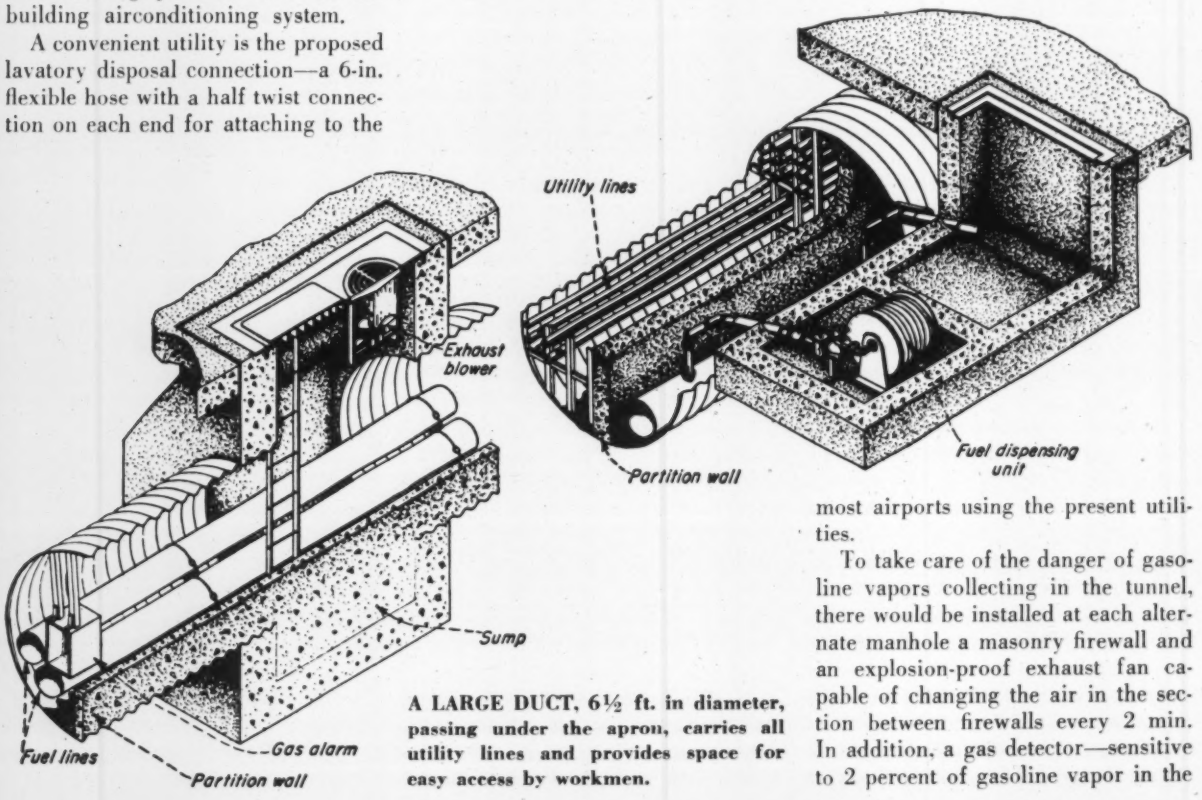
A convenient utility is the proposed lavatory disposal connection—a 6-in. flexible hose with a half twist connection on each end for attaching to the plane and to the sewage outlet in the pit. The pit connects with an 8-in. sewer pipe (inside the utility conduit) that carries sewage from all the loading positions. Attached to the 6-in. flexible sewage hose is a water line that connects to the plane and flushes the waste container inside the ship.

Less congestion, smaller ground crews

This plan eliminates most of the equipment from the apron. It places each utility where it can be reached and used with a minimum of effort. All utility hoses are on self-winding spindles. After using the equipment, the attendants simply close the pit covers, and the operation is complete.

Using this system, two men can bring the plane into the loading position and perform the ground services (airconditioning, sewage, water, checking tires, and loading and unloading baggage) while two mechanics refuel, check oil, service motors, provide electrical connections, and stand by for fire protection. Thus only four men can perform all services in much shorter time than eight men take for the same operation at most airports using the present utilities.

To take care of the danger of gasoline vapors collecting in the tunnel, there would be installed at each alternate manhole a masonry firewall and an explosion-proof exhaust fan capable of changing the air in the section between firewalls every 2 min. In addition, a gas detector—sensitive to 2 percent of gasoline vapor in the



A LARGE DUCT, 6½ ft. in diameter, passing under the apron, carries all utility lines and provides space for easy access by workmen.

air—would be installed in each section and connected to a central alarm station.

Additional safety would be provided by constructing a longitudinal 12-in. thick masonry center partition wall to divide the tunnel into two halves and act as a firewall. On each side of the longitudinal wall would be a 21-in. walkway for workmen. The electric conduits, communications conduits and related utilities, with adequate space for future additions would be in one half of the tunnel, the fuel, sewage, water, compressed air lines and related utilities in the other half.

Estimated cost of the proposed tunnel, with fuel lines and racks for other utilities installed, is $80 per lin. ft., or $12,000 for each 150-ft.-dia. loading position. The estimated cost of two fuel pits with equipment to deliver 400 gpm. of fuel is $3,000, making the total cost of the underground fuel system $15,000 per loading position. Refueling at most airports is done by trucks. To insure continuous refueling by this system requires at least two trucks—of $30,000 total cost—for each loading position.

Better apron services wanted

To obtain the viewpoint and thinking of interested people on this proposal, the design criteria for the utilities tunnel have been submitted to such groups as the Air Transport Association of America, American Petroleum Institute, aircraft manufacturing companies, and individual aviation fuel and oil companies. Comments also have been received from the Civil Aeronautics Administration, the U. S. Air Force, and the Office of the Chief of Engineers, U. S. Army. Without exception, all have stated that an improved system of apron servicing is desirable at all airports, and is a "must" in the larger cities where the aircraft and service vehicles on the apron have already reached the saturation point.

The principal criticism of such a system came from individual aviation-fuel and oil companies, based on their opposition to commingling of fuel from different companies and loss of individual company identity. Actually commingling of fuels furnished under identical specifications is no problem.

Probably the proposed system does not completely solve the problem of supplying apron utility services, but it is offered as a suggested step in the right direction. The underground system was developed after much research on apron conditions by the engineering staff of Airways Engineering Consultants, Inc., under the direction of Rufus C. Phillips, president, and Henry M. Henion, vice president.

Where Are Garbage Grinders Prohibited or Permitted?

Installation of household garbage grinders is prohibited in six cities in the United States but is permitted in 104 other municipalities. These facts were uncovered in a recent survey of cities over 50,000 population by the Committee on Sewerage and Sewage Disposal of the American Public Works Assn. E. L. Filby, principal assistant with Black and Veatch, consulting engineers of Kansas City, Mo., is chairman of the committee.

Indicating wide interest in the subject, response to the questionnaire, which was addressed to the chief plumbing inspector of each city, was exceptionally high. Replies from 34 states with a 55.8 percent return covered 16,587-household, 96-hotel and 35-club garbage-grinders.

New York, Philadelphia, Miami, Fla., Knoxville, Tenn., Youngstown, Ohio and York, Pa. prohibit use of garbage grinders. Miami permits their use if the discharge is to a private septic tank. In Youngstown, it is estimated that at least 500 grinders were installed in residences before the prohibitory ordinance was adopted.

Trenton, N. J. is considering adoption of an ordinance to prohibit use of garbage grinders.

While the survey does not give the reasons for prohibiting garbage grinders, it is suggested that the New York, Miami and Philadelphia restrictions stem from a lack of treatment facilities as well as the danger of further pollution in receiving waters. A recommendation by the State Board of Health that garbage grinders be prohibited in New Jersey cities is based on the opinion that extensive improvements in sewage-treatment plants will be needed to handle the additional organic load.

Use of garbage grinders in hotels, restaurants and clubs is permitted in 83 but barred in 17 cities. Cities prohibiting such installations are: Elizabeth, N. J.; New Haven, Conn.; Mt. Vernon and Syracuse, N. Y.; Baltimore, Md., Wilmington, Del.; Waterloo and Davenport, Iowa; Allentown, Pa.; Evanston and Oak Park, Ill.; Salt Lake City, Utah; Cincinnati, Ohio; Spokane, Wash.; Durham, N. C.; Madison, Wis.; and Los Angeles, Calif.

One reason for non-approval in six cities seems to be that a grease trap is required on waste lines from sinks.

While 22 of the cities surveyed employ sewer rentals, only five charge for garbage-grinder installations. In Oak Park, Ill. and Detroit, Mich. use of extra water increases the service charge. In Louisville, Ky., the extra water use will account for about ten percent additional revenue. In Canton, Ohio and Allentown, Pa., unit charges for garbage grinders are $3.50 and $6.00 per year, respectively.

Other facts brought out in the survey are: (1) Household garbage grinders were reported to be troublesome in 16 cities while hotel and restaurant installations resulted in operation difficulties in five cities; (2) Municipal garbage-grinding stations are used in only three cities—Lansing, Mich.; Rochester, N. Y. and Tulsa, Okla.; (3) Los Angeles has adopted regulations governing the size of ground particles—40, 65 and 100 percent must pass No. 8, 3 and ½-in. screens, respectively and (4) it is apparent that industrial use of grinders is limited. In Houston, Texas, a food-processing plant attempted to grind and dispose of egg shells in the sewers. This resulted in clogged sewers and service lines.

Wastes—such as oyster and clam shells should not be disposed of by grinding but apparently peach and plum pits can be handled.

One possible advantage is that grinding of household garbage will help to control deposition of grease.

Estimating Groundwater Supplies With Electrical Logs of Wells

B. A. Barnes
formerly Hydraulic Engineer,
Texas Board of Water Engineers
Austin, Texas

REASONABLY accurate forecasts of water quality in underground reservoirs can be made by use of electrical logs of wells under favorable conditions. Sequence and lithologic character of strata penetrated by wells can usually be determined more accurately than with the driller's log alone.

Electrical logging of wells—a geophysical procedure used extensively in the petroleum and natural-gas industries to record resistivity and natural electrical potential of earth strata—has been applied at Houston, Lubbock, Galveston and many other areas of Texas in the search for underground water supplies.

In most cases, presence or absence of water-bearing sands has been determined with a greater degree of accuracy than conventional methods permit. And both quantitative and qualitative improvement of a particular supply has often resulted from interpretation of electrical-log analysis of drill-stem water samples, and correlation with chemical analysis of water from nearby wells.

While the electrical log is an excellent tool for appraising subsurface conditions, it must be used in conjunction with other geologic data. A working knowledge of sedimentary history as well as the hydrology of the area under investigation is required. In fact it may be said that benefits to be derived from electrical logging increase in proportion to amount of geologic and hydrological data available.

The electrical log consists of two or more resistivity curves and a self-potential curve, photographically plotted to scale against well-depth in feet. Values of resistivity and self-potential in uncased holes are recorded automatically on a strip film as the emitting and receiving electrodes are lowered into the drill hole on their cables.

Resistivity curves are graphs of apparent specific resistances of strata traversed by electrodes. This record is obtained by measuring the potential drop of an induced current between known electrode spacings, with the values recorded in ohms per square meter per meter. Factors that influence resistivity of rocks are: conductivity of interstitial fluid; size, arrangement and size distribution of rock particles; degree of alteration; cementation, and to some degree mineralogical content.

Similarly, the self-potential curve is a continuous graph of changes in natural electrical potential throughout the drill-hole. Self-potential values are measured in millivolts.

The procedure employed to obtain an electrical log of a drill hole is illustrated schematically in Fig. 1-a (C. M. Schlumberger and E. G. Leonardon, Electrical Coring, *Trans.*,

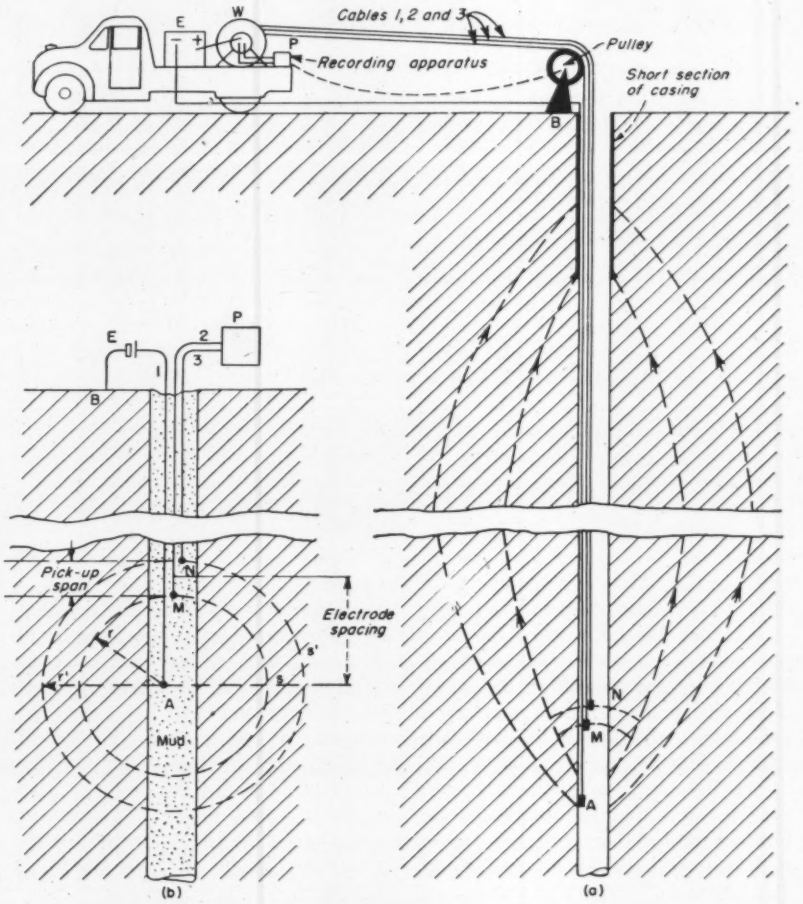


FIG. 1. ELECTRICAL LOGS OF WELLS are obtained by lowering the emitting electrode (A) and receiving electrodes (M and N) in an uncased hole. Resistivity and self-potential values are rcorded photographically to scale against depth by a potentiometer on the surface.

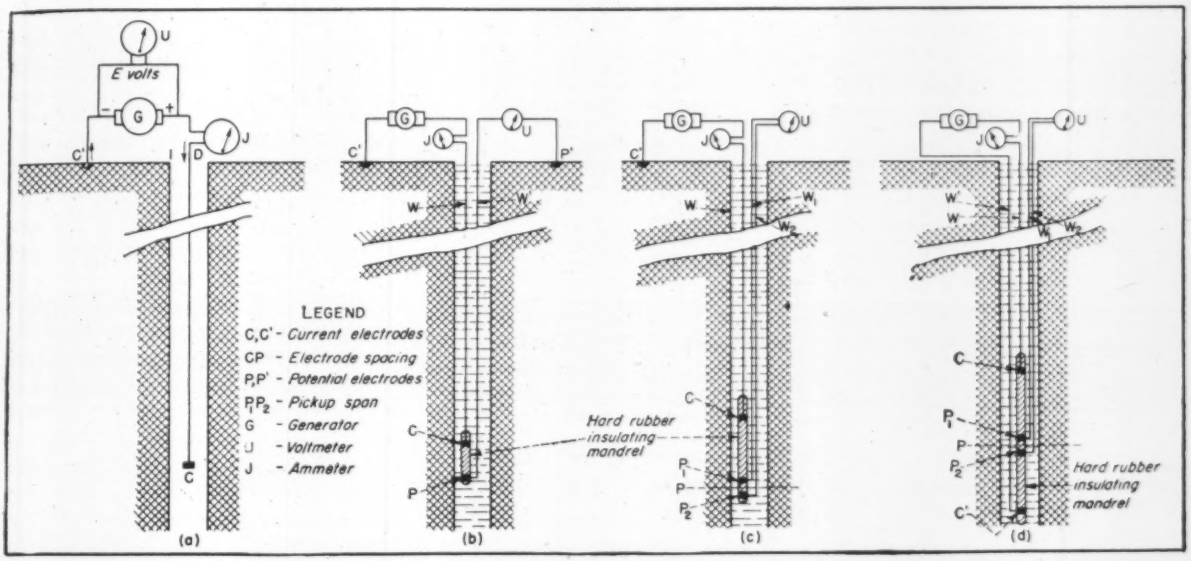


FIG. 2. SINGLE-POINT (a), two- (b), three- (c), and four electrode (d) arrangements are employed in electrical well logging. Four electrodes are used to obtain resistivity and self-potential measurements of strata not contaminated by drilling mud. (Drawing by H. Guyod, Electrical Log Interpretation, *Oil Weekly*.)

American Institute of Mining Engineers, vol. 110, p. 240, 1932). A current of known intensity is delivered to the emitting electrode (A) in the hole by cable (1) from generator (E) on the surface. The circuit is completed by grounding the opposite pole of the generator at the top of the hole (B). This is done usually on a short section of metal casing. Carried back by cables (2 and 3), the potential drop between pickup electrodes (M and N) is measured by a potentiometer (P) on the surface.

In practice, electrode cables are wound as a single strand on a winch geared to the photographic recorder. The recorder, winch and generator are mounted on a truck for mobility.

Knowing current intensity, I, and the drop in potential, V, between two concentric spheres, s and s', of radii, r and r', the resistivity of homogeneous and isotropic (having same properties in all directions) media may be computed from the equation:

$$\rho = \frac{4\pi V}{I} \times \frac{r\,r'}{r' - r}$$ (Fig. 1-b)

To obtain accurate resistivity values of sediments penetrated, a number of multiple-electrode arrangements—each with a particular advantage—are in use. With the exception of the single-point procedure, all of the arrangements are essentially multi-electrode systems (Fig. 2). The designations—two-, three- and four-electrodes—refer to number of units that traverse the drill hole.

Each electrode arrangement produces a characteristic resistivity curve—a factor that must be considered when electrical-log results are interpreted. (Electrical Well Logging. Hubert Guyod, *Oil Weekly*, Aug. 7 to Dec. 4, 1944, Houston, Texas).

In rotary-drilling practice, the hole must be filled with a relatively dense fluid. This fluid or drilling mud transports cuttings to the surface, and prevents uncased holes from collapsing in unconsolidated or poorly packed sediments. The weight of the liquid column usually causes infiltration of mud filtrate into exposed permeable beds. Since introduction of foreign matter alters the interstitial fluid of the beds for some distance beyond the periphery of the drill hole, resistivity values obtained within the contaminated zone do not represent actual apparent resistivity.

To obtain measurements beyond the influence of drilling-mud infiltration, most electrical logs of water wells consist of three resistivity curves. The first, second and third curves refer to the shortest, intermediate and longest electrode spacings, respectively.

While electrode spacings may be selected to solve a particular problem, experience has shown that certain fixed spacings will give accurate information for broad geologic provinces. For example, electrode spacings commonly employed for water-well logging along the Gulf Coastal Plains of Texas are 10 in., 39 in., and 15 ft. for the first, second and third resistivity curves, respectively.

Electrical logs trace sediments

Sands in unconsolidated sediments along a line of wells bearing southeast through the central part of Galveston County and then northeast almost to the southern border of Chambers County, Texas (Fig. 3) have been correlated from electrical logs. In addition, these strata have been traced some 30 miles on each side of the line from other electrical logs.

Two zones predominate in the geologic section through the line of wells: a top zone (Upper Beaumont clay) and below this, a massive sand (probably basal sand of the Beaumont clay formation) varying from 90 to 170 ft. in thickness.

In the top layer, the lenticular character of sand deposits is of particular interest. At the northwest end of the section, an electrical log of an oil test-well shows only one sand of water-bearing value between 422 and 457 ft. below the surface. The number of sand members in this zone, however, increase as the stratum dips to the southeast until the total thickness of deposits in the Texas City area

is sufficient to warrant development of city and industrial supplies.

Due to lack of continuity of the sands, water transmission in this zone is comparatively low. This results in excessive drawdowns under moderate withdrawals and limits the volume of water that can be developed within any specific area.

The underlying zone (basal sand) is the principal aquifer in the southern parts of Harris and Galveston and the north of Brazoria Counties.

Searching for a city water supply

Electrical logs of five test-wells were made for the city of Lubbock, Texas in a search for an additional water supply of 10 mgd. Located in Lubbock County, the wells were drilled through sediments of the Ogallala formation, which furnish most of the usable water in the High Plains region, into underlying Cretaceous and Triassic rocks.

One purpose of the exploratory program was to gather data on the available supply of water in the basal Cretaceous sands and the upper portion of the still deeper Triassic strata. Basal Cretaceous sand was found both in the driller's logs and electrical logs of wells Nos. 1, 9 and 10, but was apparently absent in electrical logs of wells Nos. 2 and 4. (Part of the geologic section as well as the map of well locations is shown in Fig. 4.) As Cretaceous sands were either relatively thin or entirely absent and Triassic beds were predominantly in clay throughout the section logged, the proposal to develop water in these strata was abandoned. (Joe W. Lang, Water Resources of the Lubbock district, Texas; Texas Board of Water Engineers, July, 1945.)

Electrical logs of oil and gas test-wells can be applied to estimate groundwater resources. These logs provide an excellent source of accurate data along the Coastal Plain of Texas where groundwater aquifers are being correlated. In this region they are especially valuable because driller's and electrical logs of water wells penetrating the full thickness of the fresh water zone are not available. As an example of the value of electrical logs, it has been estimated that water-bearing sands range from 100 to 600 ft. thick in the southern third of Victoria County, Texas.

No relationship between electrical-

FIG. 3. WATER-BEARING SANDS in unconsolidated sediments along a line of wells in Galveston County, Texas were correlated from electrical logs.

log values and permeability of underground strata is known. It appears probable that in sand-type reservoirs the factors that contribute to increasing resitivity—such as, wide range in grain size, distribution of grains and cementation—also tend to lower permeability.

Several sources cause the anomalies recorded in the self-potential graph among which the most important are:

1. Electrochemical effect produced by differences in chemical composition and/or concentration of the drilling-mud fluid and the fluid in a particular stratum;
2. Electro-filtration potentials (caused by flow through a permeable medium).

Data now available indicates that in water wells the electrochemical effect is by far the most important source of the recorded self-potentials.

Water-quality forecast

Interpretation of electrical logs for forecasting water quality is based on a fact and an assumption.

The fact is that an increase of salts in solution in the interstitial water causes a decrease in resistivity. The assumption is that the electrochemical action is the major factor contributing to the self-potentials recorded on the electrical log.

Due to differences in electrochemical properties, it is not possible to estimate the change in quantity of each of the salts from anomalies recorded on the electrical log. In many areas the change in concentration is often confined to one or two salts, thereby permitting anomalies on the electrical log to be interpreted in a restricted sense with moderate success. Each of the salts in solution has its proportionate effect but anomalies recorded on the log are the resultant of all such influences.

The following is an example of correlation of the electrical log with quality of water at several horizons in a test well owned by the City of Galveston and located near Hitchcock in Galveston County. From an analysis of a sample taken from a nearby well in sands about 700 ft. below the surface, water in the top of basal sand (Beaumont clay) was found to contain about 100 ppm. of chloride. Since resistivity values remained essentially the same to a depth of 930 ft., it was assumed that quality of water in the intervening 230-ft thick section did not change materially.

Between 940 ft. and 1,023 ft. (the base of the sand), decreasing resistivity values indicated a zone of rapidly increasing dissolved salts. To confirm this forecast, water samples were obtained at 940- and 1,023-ft. depths. These samples contained 175 and 1,380 ppm. of chloride, respectively.

In addition, the electrical log indicated—by lower resistivity and increased self-potential—that water in sands below the base of the main aquifer (1,023 ft.) was still more highly mineralized. A sample obtained at a depth of 1,152 ft. contained 3,820 ppm. chloride.

To obtain data necessary to select or reject production-well sites at a minimum cost, this test procedure was followed:

After a test well had been drilled to the required depth, an electrical log was obtained. Chloride in the water was then estimated from the log and a depth selected from which a sample was needed to verify the log interpretation. Obtained by the drill-stem method, the sample was usually taken near the base of the sand stratum—usually the zone of highest concentration in this area.

Based on analysis of the sample and change in resistivity shown by the electrical log, the chloride in the water for a hypothetical well screened through the full section of sand was estimated. If estimated total chloride fell below 250 ppm., the site was accepted for well development.

The following table gives estimated chlorides in water from a hypothetical well at the Galveston test site as well as chloride content in samples from producing wells that were later

drilled at locations 150 to 700 ft. from the respective test hole:

Test well No.	Estimated chloride ppm.	Production well No.	Chloride content ppm.
5-8	240-250	9	224
1-4	120-130	10	148
3-6	210-220	11	245
6-9	170-180	12	134
11-14	190-200	13	170
2	290-300	14	294

Along the Gulf Coast of Texas, the predominant variation is in chlorides in the interstitial water. In the Lufkin area of Nacogdoches and Angelina Counties, the principal change is limited to a low concentration of bicarbonate in Carrizo sand and larger amounts of this salt in the upper Wilcox sands.

Industrial supply investigated

In connection with the development of an industrial supply in the Lufkin area, electrical logs were employed to estimate quality of water in underground reservoirs. One log shows two thick sand strata between 620 and 880 ft. below the surface separated by a clay bed between 723 and 745 ft. The upper layer is Carrizo sand and the lower bed is sand at the top of the Wilcox group.

The following partial analyses of samples collected in the two strata indicate that water in each aquifer is of similar concentration with the exception of bicarbonate:

	Bicarbonate (HCO_3)	Sulphate (SO_4)	Chloride (C_l)	Total solids
Carrizo sand..	166	53	16	220
Wilcox (upper sand)	438	50	16	550

The difference in chemical characteristics of water, reflected in lower resistivity and increased self-potential values on electrical logs, provides a basis for separating Carrizo from upper Wilcox sands in the water wells.

Since no definite water-quality data are available for any specific aquifer penetrated by oil test-wells, the following procedure for estimating changes in ground-water quality has been found sufficiently accurate to warrant use of oil-test logs. Analyses of water samples taken from nearby wells screened at known horizons are correlated with equivalent sections of the oil-well electrical log. (The accuracy of the interpretation is increased in proportion to the number of correlations that are established.) Changes in quality of groundwater are then estimated from variations in the resistivity and self-potential values of the sand strata in the test well.

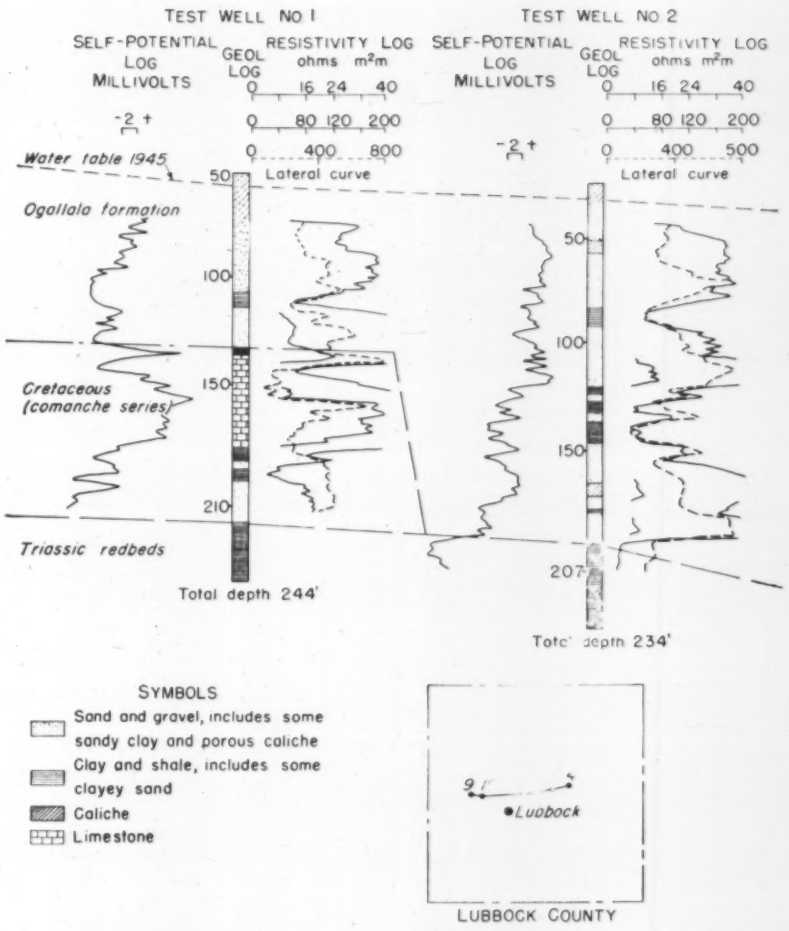


FIG. 4. PART OF THE GEOLOGIC SECTION of five electrically logged test-wells in Lubbock County, Texas, shows that the water-bearing strata (Cretaceous) disappears between wells Nos. 1 and 2.

Undoubtedly errors will occur due to lack of definite controls. For example, in estimating quality of water from changes in self-potentials, it is assumed that chemical composition of drilling mud remains constant. Actually dissolved solids in the mud usually increase with depth.

Principal advantages of the estimating procedure are: It establishes in most cases a reasonably accurate limit below which it is useless to prospect for potable groundwater supplies, and it brings into use a large volume of data that otherwise would not be gathered due to cost. Certain areas can often be eliminated as potential well-development sites on the basis of electrical logs of oil test-wells, thereby greatly decreasing the cost of prospecting for and developing of groundwater supplies.

Advantages summarized

Chief value of the electrical log in quantitative studies is that stratagraphic sequence of geologic beds may be determined with greater accuracy than provided by the driller's record. This is especially true in regions where sediments consist of a succession of clays or shales, sandy clays or clayey sands interbedded with sands or sandstones. In addition, use of the electrical log permits correlation of water-bearing sands over wide areas.

When the electrical log is used in conjunction with chemical analyses of water samples, it may be used (with certain restrictions) to estimate changes in quality of water in under ground strata.

GALVANIZED GARBAGE CANS of uniform design, collection by city trucks for grinding and disposal of garbage at the city's sewage treatment plant (at left), plus mechanical washing and delivery of sterilized cans to the user (at right), encourage public cooperation with operation and financing of . . .

Garbage Collection in Lansing, Mich.

No ODOR, no flies, no unsightly spillage and virtually no customer dissatisfaction are the net results of the garbage-collection methods employed by Lansing, Mich. The system is simple—city-owned garbage cans are furnished the user at a nominal rental, city crews collect the garbage and haul it to the sewage treatment plant where it is ground and introduced into the digestion tanks, and a sterilized can is left with the user for the next collection.

The city controls a total of 21,990 garbage cans, of standard design and 9-gal. capacity, serving about 19,700 residences, hotels, restaurants, etc. The rental price to the residential user having but one can is only $3 per year, with a 50-cent discount for prompt payment. Yearly charges for commercial collections are $3.75 for two collections per week; $5 for three collections and $7.50 for six collections per week, with appropriate discounts for prompt payment. Average cost of collection is $13.50 per ton of garbage, including dumping, grinding the garbage and washing the cans.

During the three-month canning season the total collection reaches 90 tons of garbage per day. A total of 10,850 tons of garbage was collected last year at a cost to the city of $146,800. Of this amount, $57,900 was received from can rentals and $3,000 from the sale of bones for fertilizer. The remainder of the cost of garbage collection comes from the city's general funds.

Individual contracts

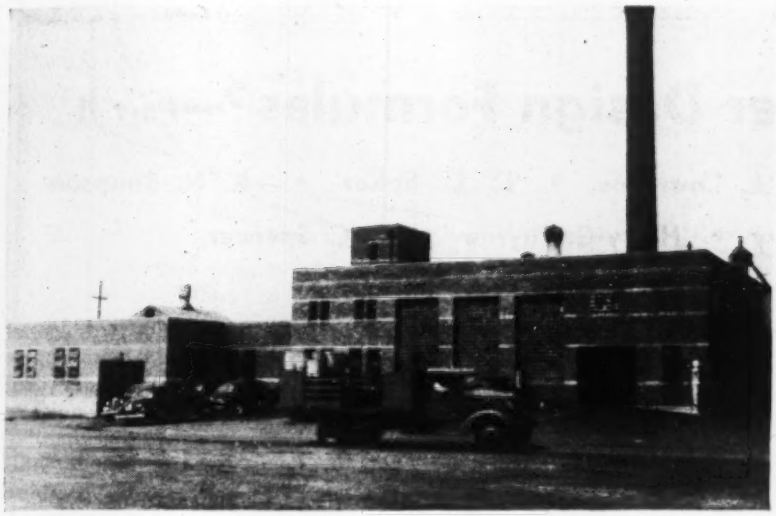
Collection of garbage begins with a separate contract between the city and each garbage producer, in the form of a customer's receipt for the rental of a garbage can. Along with the receipt goes a copy of the Garbage Ordinance which defines "garbage", limits the type of container and restricts its placement, forbids private collection, requires the renter of the cans to be responsible for their loss or damage, and lists the penalties for not complying with the ordinance.

Customers are billed each April 1 and, if payment has not been made within four weeks after it is due, the garbage can is picked up by the city. If garbage is thrown on the ground or is not kept in city cans it is considered a health menace and is reported to the city health department. It may, however, be burned or buried on the owner's premises with the approval of the health department.

In residential areas where each householder has one can, collections are made twice a week during July, August, and September, and once a week during the remainder of the year. Hotels, restaurants, produce markets and apartment houses with three or more cans in the downtown area have daily collections. In outlying areas the collection from multiple can holders is made three times a week. The cans are picked up at the back door of residences, and sterilized cans are left in exchange.

The city operates seven trucks in winter and twelve in the summer. Each truck picks up an average of 240 cans per load and makes three loads a day. The city is divided into routes for the various trucks, and loading requires traveling about 2 mi., with a 3-mi. average haul to the sewage treatment plant. Truck crews operate on a route-assignment basis with three complete trips, totaling 600 to 700 cans, constituting a day's work regardless of whether or not it requires 8 hr.

When starting out on a collection the trucks are loaded with clean cans, stacked at the rear of the truck and nested so as to take up a minimum of space. Each truck has a driver, two



COLLECTION TRUCK with 240 clean cans starts its daily run from city's ten-year old sewage treatment plant—garbage grinding room is at extreme left.

collectors and a stacker. Full cans are loaded onto the front of the flat-bed trucks, which have staked sides made of steel channel posts and side rails. One section on each side of the truck is removable for loading and unloading. Partially filled cans are emptied to fill other cans, with the empty cans being nested on the truck and carried along for washing at the sewage treatment plant. Can-covers are left at the houses.

The men collecting the filled cans are equipped with a black "Sam Brown" belt with a heavy leather pad at the hips to prevent undue strain on the collector while carrying from two to four cans at one time.

At the sewage treatment plant, the cans are unloaded and emptied into a garbage grinder. Garbage is raked before grinding to remove metal and stones that would damage the grinder. The shredded garbage is injected into the plant's digestion tanks through a pneumatic tube.

Washing the cans

The empty cans are placed on a conveyor and washed mechanically in water at 190-deg. temperature, following which they are nested in stacks suitable for loading onto an empty collection truck. Average life of a garbage can is 3½ years.

The garbage cans are galvanized iron, corrugated on both sides and bottom to prevent the garbage from sticking to the metal in cold weather. They are hot-galvanized after forming. The cans are purchased by the city on competitive bids, in lots of 7,000. They are of uniform size and shape to permit cleaning by mechanical process, and have two hinged handles to facilitate handling and to permit nesting.

Garbage grinding facilities were included as an integral part of the city's 9-mgd. sewage treatment plant when it was constructed about ten years ago. At that time, the plant was reported to be one of the first in this country designed specifically for the grinding of garbage for disposal in the plant's digestion tanks. For design details see *ENR* June 23, 1938, p. 878. Operating experiences are discussed in *ENR* Sept. 26, 1940, vol. p. 407.

Proposed plant expansion

Existing sewage treatment facilities are inadequate for the city's needs. In fact, the plant has been overloaded for the past five years. Current plans call for enlarging it to 20-mgd. capacity based on 3-hr. detention in the primary settling tanks.

Expansion of the plant's sewage-treatment facilities may be performed by stage-construction, with the first item covering the construction of six 80-ft. dia. digestion tanks to supplement the present four 60-ft. dia. digesters. Four 200x20-ft. aeration tanks also are to be added under the proposed expansion program. Funds for the improvement are included in a $3,300,000 bond issue which was approved by a referendum vote at recent general elections.

Harold Springsteen is superintendent of garbage collection, and George F. Wyllie is superintendent of the sewage and garbage disposal plant; both reporting to Glenn P. Manz, director of public service and city engineer.

Driveway Rentals Provide Extra Municipal Revenue

An unusual method of controlling ingress and egress between public streets and business establishments and obtaining revenue for the municipality at the same time has been put into effect in Lincoln, Nebraska, according to the Highway Research Board. This is accomplished by enactment of an ordinance providing for annual rentals for business driveways across the public sidewalk areas in certain districts.

Justification for enactment of the ordinance rests on the theory that passage of vehicles over sidewalks constitutes a hazard to other vehicular traffic on the street and also to pedestrians on the sidewalk.

Driveways, according to the justification for the ordinance, materially reduce much needed street-parking facilities. The use of driveways is further considered to be a "special and valuable privilege . . . constituting a use of public property for private gain to the detriment of the public in general."

Rentals are to be collected from owners of property in certain business, commercial or industrial districts if driveways across the sidewalks provide access to such establishments.

Rentals are planned to be based on the greatest width of the driveway at the point where it enters the travelable portion of the street or at the outside or curb face line. Owners of property in local business and industrial districts must pay $1.00 per foot for driveways while driveways in commercial districts are assessed at the rate of $2.00 per foot.

Lists of such driveways and names of property owners concerned are to be prepared annually by the city engineer for use of the city treasurer in collecting rentals.

What's Wrong With—

Sanitary-Sewer Design Formulas?—Part II

James R. McComas • R. E. Lawrence • L. L. Sphar • R. N. Simpson
Thomas B. Henry • Harry G. Payrow • C. C. Spencer

Present-day practices for designing sanitary sewers were recently indicted on two counts; a wide variation in methods for estimating sewage flow and a scarcity of actual flow measurements in sewers from which specific-locality design formulas can be derived. The indictment was made by Richard Bennett, hydraulic engineer, city engineer's office, Phoenix, Ariz., in an article, "A Critical Appraisal of Sanitary-Sewer Design Formulas" (*ENR*, Oct. 14, p, 102).

Considerable interest in the subject of sanitary-sewer sizing has been generated by Mr. Bennett's provocative discussion. This is evidenced by the large number of comments that have been received from sanitary engineers.

To report how practicing engineers feel about Mr. Bennett's contentions, a series of comments is being published. This is the second article in the series, the first appearing in *ENR*, Nov. 25, p. 76.

Among the conclusions put forward by authors in this installment are: (1) Before sewers are designed, every factor that might influence sewage flow should be fully evaluated; (2) Sewage flows vary widely with the type of occupancy in each area; (3) Actual sewage flows should be measured and studied to provide better design bases; (4) It should be recognized that per-capita flows vary widely; (5) A design flow of 100 gal. per capita per day is not in great error; and (6) Industrial discharges must be evaluated. Detailed comments follow.

Per-Capita Flows Vary Widely

James R. McComas
Assistant Sanitary Engineer
State Department of Health
Baltimore, Md.

Mr. Bennett's indictment of the shortcomings in teaching and the practice of sanitary-sewer design is to a large extent justified but it is too extensive in its coverage.

He correctly refers to the absence in text books of clean-cut rational methods of design based upon calibrated data. Text and class-room instruction, to a great degree, follow totally abstract procedures such as he emphasizes, particularly with respect to sewers flowing half- or two-thirds full. Economy dictates that full capacity be used. Why waste any capacity?

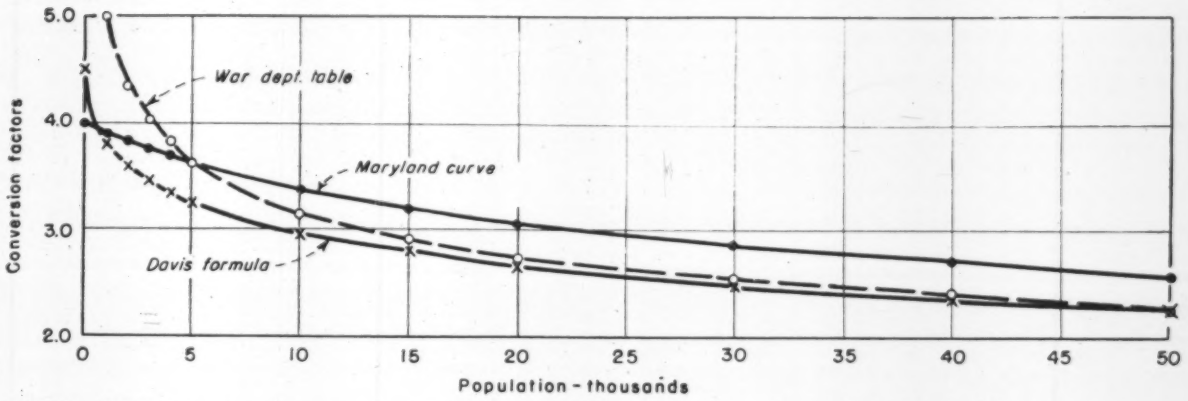
Irrespective of the basis of design, whether by acreage or population which can be and are interchangeable, use of a conversion or flow factor for design curve is indispensable. It cannot, obviously, be obtained from sewers that are to be constructed; therefore, it must be estimated from existing records qualified as closely as possible by local conditions.

Per-capita flow or flows per acre vary from city to city and also within a city. Excessive water usage and sewage flows, as obtain in the wealthy section of Phoenix, are not comparable elsewhere. Possibly air conditioning is responsible for the wide variance. If so, such water should be discharged after use to storm drains to relieve sanitary sewers and treatment works. The Phoenix rate appears to be extreme. Absence of infiltration is also unusual. By contrast, sewage flows from one wealthy residential area in Baltimore, Md., was appreciably lower for many years than elsewhere in the city. Air conditioning was not in vogue at that time.

The Louisville data include infiltration rates eight to ten times those accepted today. Likewise, population densities are high, causing the curve to have extreme values. Sanitary sewers designed for 800 gal. per capita in residential areas would suggest wasted capital investment. Rational excess capacities for unforeseen contingencies are justified but should not be pyramided. Providing sewer capacity for several future generations —or for unpredictable population growths throughout a city—creates a present-day financial injustice and can result in undesirable sewer-flow characteristics. Possibly a fair future index is the normal length of bond issues, or say for 40 years.

The principle of the Phoenix and Louisville curves is the same although they differ slightly for the smaller and larger areas. For Phoenix, no change is made in relationship between average and maximum flows for areas of 50 acres or less. This transition point apparently is arbitrary because laws of probability and actual gaging records made elsewhere dictate that all users within a 50-acre area will not contribute peak loads simultaneously. The divergence should start immediately in the same manner that storm-drain design intensity is decreased with the first run of the uppermost drain. In other words, the log log curve should be a straight line and the arithmetical-scale presentation should be a continuous curve.

A short article by this author (*ENR*, June 10, 1926, p. 951), presents data for a conversion curve (average vs. design flows) prepared by plotting gaged records from sanitary sewers in a number of eastern



THREE CURVES for factors to convert average to design sewage flows are compared in this graph.

cities. A reproduction of this curve with an insufficient explanation appears on p. 236 of American Sewerage Practice, Metcalf and Eddy, Vol. 1, 1928 ed., McGraw-Hill Publishing Co. In its early development, it was used exclusively to design the then largest sanitary-sewer system in this country—for Baltimore with a 1908 population of 550,000. Later, the graph was used by the New York's Metropolitan Sewerage Commission. After slight modification, it was adopted in 1914 by the Maryland State Board of Health and since then has been used continuously in Maryland.

During World War II, the War Department Technical Bulletin. *Sewerage and Incineration*, p. 2, April 23, 1941, included a table for design of sanitary sewers at military installations. Average per capita flow used was 70 gpd with conversion factors ranging from 5.0 to 2.28. The curve closely parallels the Maryland graph with its range of 3.90 to 2.56 for the same flows.

Formula for maximum flow

In the Handbook of Applied Hydraulics, C. V. Davis, 1st ed., 1942, p. 878, McGraw-Hill Book Co., a formula is reproduced for maximum design flows. This closely parallels the Maryland curve and has ratios of 3.80 to 2.27 for comparable flow ranges. Basically, all of the curves use population rather than acreage as the criterion. Their similarity and comparable values are significant, as indicated in Fig. 1.

Design of Sewers Requires Full Study of All Factors

R. E. Lawrence
Black & Veatch, consulting engineers
Kansas City, Mo.

Mr. Richard Bennett effectively points out limitations and errors which can arise from indiscriminate use of design-curves in sewer-size determinations. He apparently feels that there is a growing tendency on the part of designers to use generalized curves without giving adequate consideration to special features which materially affect the design. Such a trend probably results in part from wartime practice when design of sewer systems and treatment works for military establishments was based on standard factors. Experience has shown that for the most part, design of such systems was adequate, but it must be remembered that the characteristics of the individual military establishments were well known and, in practically every case, involved entirely new systems.

The procedure suggested by Mr. Bennett, involving the development of a design-curve applicable only to the individual system, is entirely practicable and highly desirable where sufficient data can be accumulated over a period of time to permit development of such a curve. However, in many cases the required data, including accurate information on zoning and other factors which affect the character of the system, cannot be determined prior to design.

Engineering design becomes necessary when an existing system becomes inoperative from loads or damage. Types of problems include the following:

a. Extensions for future growth where mains are adequate.

b. Extensions for future growth requiring additional trunk capacity.

c. The addition of main and trunk capacity made necessary by lateral extensions which will overtax the capacity of the existing system.

d. Collecting mains and relief sewers.

e. Outfall sewers and disposal works.

Each type of problem for each community is complex and requires much more study than the application of a design-curve or a sewer-size formula.

Sewage measurements

Adequate engineering studies must, in any event, include sewage measurements that will reflect daily variations in sewer operations, relation of sewage flow to water consumption and groundwater infiltration, and a study of the potentialities of the area. The factor of safety, in terms of capacity, to be applied to an individual design must, of necessity, be based largely on the judgment of the engineer and his appraisal of the future potentialities of the area to be served. No economical design can preclude the possibility of relief sewers at a later date if, during the intervening period, sewer requirements change drastically as a result of re-zoning, indus-

trial development or unanticipated growth.

The important consideration, and the one emphasized by Mr. Bennett, is the fact that sewer extensions cannot be properly designed without definite information on the character of the system.

Lack of Design Curves Prevents Mis-application

L. L. Sphar
Packer and Hill, Consulting Engineers
Seattle, Wash.

The subject of sanitary-sewer design criteria is one of great interest in this office because we frequently spend much more time and effort in selection of flow factors than we do in their application. Many of our sewerage projects involve new developments rather than extensions to existing systems so that we are commonly faced with the problem of evaluating, without access to much factual information, such variables as nature and extent of probable growth, infiltration and storm-water inflow, as well as amount and variation of domestic, commercial and industrial flow.

Available operating data from other localities can be used only as a general guide to design inasmuch as many of the above enumerated factors may vary widely, even in adjoining areas.

Infiltration a bugaboo

Infiltration is a bugaboo of major importance, sometimes constituting more than half the design flow. We find that this factor depends not only on soil and ground-water conditions but also on construction specifications and their enforcement. Data from existing systems are most useful only when supporting information on sub-surface conditions and construction practices employed is made available.

Storm inflow from downspouts and infiltration from foundation drains cannot be entirely eliminated by ordinance. It is very difficult to ascertain the number of illegal connections in a system or to predict the number that will occur in a new area.

We feel better able to predict nature and extent of growth than to evaluate infiltration and storm flow. Per-capita average and maximum flows are assigned to each sub-area in accordance with our estimate of probable ultimate development. To resultant flow, we make additions to provide for commercial and industrial possibilities and include a storm and infiltration factor. The resulting total design flow from the sub-area is usually, therefore, only a "guestimate", even where operating data may be available from a nearby installation.

Straight-line accumulation of flow is generally used in choosing trunk-sewer sizes. This is a frank admission of the "factor of ignorance", which exists, coupled with the conviction that it is better to risk probability of over-design than possibility of under-design. Even so, the actual factor of safety seldom exceeds values which are commonly accepted in other branches of engineering. Under-design of laterals due to application of straight-line methods has not come to our attention.

Lack of published design curves may perhaps be fortunate, in that such mathematically precise devices are tempting and might result in even more widespread mis-application of design data than now occurs.

It should be re-emphasized that design of sewers must not only be predicated on the engineer's appraisal of existing conditions but also on those likely to exist in the area under consideration.

Type of Occupancy Governs Area Factors for Sewage Flow

R. N. Simpson
Sanitary Engineer, Gilbert Associates, Inc.
Reading, Pa.

Mr. Bennett's article on sanitary sewers emphatically points out the need for a comprehensive preliminary survey before a sewer system or additions to a sewer system are designed for a municipality. The inherent weaknesses of existing formulas and design curves were stressed quite well and certainly indicate the need for more fundamental data. Since many engineers make it a practice of obtaining this design data, a comprehensive survey of various engineering firms could well lead to a compilation of data which would shed more light on the problem.

One point that could have been stressed a little more is the importance of infiltration into sewers. A number of references were made to the Phoenix, Ariz. sewer system as a typical example. Conditions experienced along the coastal plains would be much different from those at Phoenix due to the high water table and the sandy soil. The type of construction in the high water-table areas is very important and cannot be overstressed. Some installations require cast-iron pipe with lead joints to reduce infiltration to a minimum. Some engineers are satisfied with cement-mortar joints; others demand joints made of asphaltic compounds with or without a cement-mortar wipe.

Another important design factor is the effect of storm water on the system. I have in mind one particular installation where an unsatisfactory plumbing ordinance allows roof drainage and french drains to be connected to the sanitary system. In cases like this, additional factors of safety must be used to allow for the heavy storm-water flows.

Broad assumption necessary

Although the author points out that the ideal method of design is to base conclusions on existing flow data, this is not always possible. In many housing developments today, it is necessary to design sewers without flow precedents. In such a case, many broad assumptions must be utilized to select an adequate system.

Use of an area factor is not always applicable, especially in many housing-development sections. A factor which is applicable for an apartment-

house area certainly will not apply to an area devoted to single-dwelling units.

Mr. Bennett should be complimented upon his presentation of this controversial subject. At one sewage-works meeting recently, I heard two superintendents from large cities disagree on minimum size for sewer pipes. While one engineer would never install anything less than an 8-in. pipe, the other, who felt that this was poor economy was equally adamant about the installation of 6-in. minimum lines. As long as men who are closely connected with the operation of the sewer system can not agree, it will be difficult for consulting engineers to obtain proper design criteria.

Sewage-Flow Studies Needed As Basis For Rational Design

Thomas B. Henry
Consulting Engineer
Toledo, Ohio

Mr. Bennett's appraisal of sanitary-sewer design formulas points to the need for thorough study and research to determine reasonable factors applicable to rational design. His article also illustrates the danger of accepting a rule-of-thumb method or formula which has no relation to the conditions of a problem for a particular city or area.

Sanitary-sewer design can be rational and based on reasonable estimates of various increments of flow, including domestic, commercial, industrial and institutional sewage plus groundwater infiltration. A thorough study of existing conditions and planning and zoning maps, where available, will be effective in establishing reasonable estimates of various factors affecting rates and volumes of sewage flow for which provision is to be made. Certainly there is no justification in the general application of any formulas based only on area or population served.

Urban-area studies needed

There seems to be definite need for wider and more frequent publication of studies of urban areas, covering such factors as population density, character and extent of commercial and industrial development, water consumption classified as to consumers, pertinent data on schools and other institutions, and including measurements of actual sewage flow at such places and times as to permit evaluation of the various increments making up the total. Publication of a number of such studies would serve to illustrate the danger of generalization in the application of formulas based only on area or estimiates of population.

Studies such as briefly outlined above are necessary for rational design in developed areas. For undeveloped areas the plan and character of proposed development will provide necessary factors upon which to base reasonable estimates. Some rational basis of design is almost always available so there seems to be little reason for the general use of arbitrary formulae other than disinclination on the part of the designing engineer to arm himself with the facts.

Sewer-Design Practices Defended

Harry G. Payrow
Associate Professor of Sanitary Engineering
Lehigh University, Bethlehem, Pa.

It is questionable whether a statement that wide and wild variations in sewer design in present-day practice is justified. The author further states that in the past most sewers have been designed haphazardly. The past may be 50 years or more ago but certainly within the last 30 years sanitary engineers have come out of the desert and have indeed used technical skill in sewer design.

Graduate sanitary engineers, within at least the past 30 years, well know that formulas or curves developed for certain localities are not to be used indiscriminately. Most textbooks on the subject warn that use of empirical formula should be restricted to the locality indicated and then used with great caution. The simplicity of such formula is a temptation to use them. There are situations where an initial sewerage system must be designed and with no record of the water supply to assist in estimating sewage flow. It is the custom to use 100 gal. per day per capita in such cases. This amount is not in great error, perhaps 20 percent but less in most cases. The gaging of sewage flow has a probable error of from five to ten percent.

The sanitary-sewerage survey for Phoenix is commendable and should inspire engineers to do likewise, especially where extensions, of an already installed system, must be designed. It is no great task to gage sewage flow and it does give pertinent data for design. The value of the author's paper seems to me to largely concern the description and results of his sewerage survey.

Sampling Data Needed

C. C. Spencer
Assistant Professor of Sanitary Science
School of Public Health,
Columbia University, New York, N. Y.

It is evident that the local conditions in Phoenix require a sewer design somewhat different from that found suitable in many cities of the United States. Selection of 15 persons per acre as the ultimate average population density would limit the usefulness of the curve in eastern cities where this figure may reach several hundred, and where the water usage in various districts is considerably more uniform than indicated by Mr. Bennett. However, the curve closely resembles those for thinly settled residential areas given on p. 877. Handbook of Applied Hydraulics, C. V. Davis, McGraw-Hill Publishing Co.

The development of the curve in Fig. 2 on p. 104 appears justified for large and small areas but much less so for intermediate areas. Without more extensive data than is given in the article on the duration and methods of sampling, it is not possible to comment intelligently on the form of this curve. It does appear to give low values for the areas under 100 acres in size.

The factors of safety described as "ample" appear to vary excessively depending on the area involved.

Calculating Critical Depth In Trapezoidal Channels

Warren De Lapp
Assistant Professor, Department of Civil Engineering,
University of Colorado, Boulder, Colo.

CRITICAL flow depth in trapezoidal channels may be determined quickly from a nomograph that gives approximate results sufficiently accurate for practical use.

Critical depth in open-channel flow is defined as the depth at which total energy in the flow with respect to the channel bottom is a minimum. Since this depth is the division between streaming and shooting flow and appears in many problems in open-channel flow, it is often necessary to determine critical depth when rate of discharge and channel shape are known. This may be done by differentating the expression for the energy with respect to the depth and equating the result to zero:

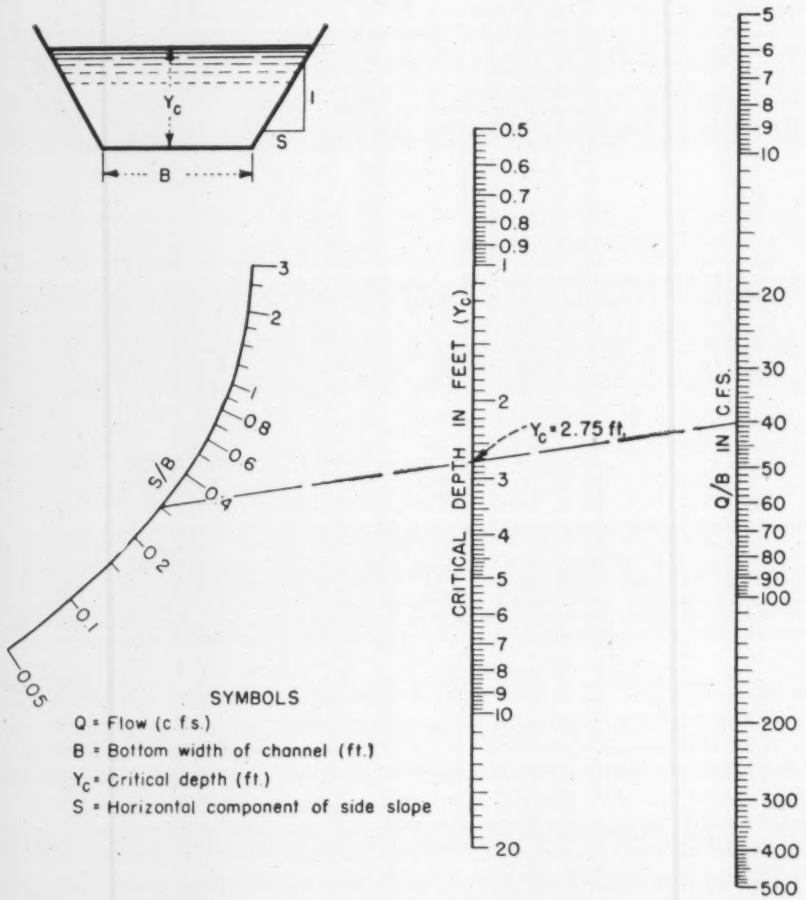
$$H = y + \frac{V^2}{2g} = y + \frac{Q^2}{A^2\,2g} \qquad (1)$$

$$\frac{\partial H}{\partial y} = 1 - \frac{Q^2\,\partial A}{gA^3\,\partial y} = 0 \qquad (2)$$

Where

H = energy head
y = depth of water in channel (ft.)
V = velocity of flow (f.p.s.)
g = gravitational constant (32.2 ft. per sec. per sec.)
Q = flow (cfs.)
A = area of water section (sq. ft.)

(B. A. Bakhmeteff, Hydraulics of Open Channels, McGraw-Hill Book Co., 1932).



CRITICAL DEPTH OF FLOW in a trapezoidal channel is determined quickly from this simple nomograph.

If $\partial A = T\,\partial y$, critical depth will occur when

$$\frac{Q^2\,T}{g\,A^3} = 1 \qquad (3)$$

where T is channel width at water surface.

Introducing mean depth, y_m, defined as $\frac{A}{T}$, Eq. (3) may be solved for the critical velocity,

$$V_c = \sqrt{g\,y_m} \qquad (4)$$

from which Q may be calculated when depth is known, since $Q = AV$.

The more common problem, however, of determining critical depth, y_c, when Q is known must be solved by trial for a trapezoidal channel.

The accompanying nomograph will be found useful in the solution of this problem. Although Eq. (3) does not lend itself to exact nomographic representation, results obtained will be found sufficiently accurate for most work as well as an aid in determining the exact value of critical depth if this is required.

Example: Find the critical depth in a trapezoidal channel with a bottom width of 5 ft. and 1½:1 side slopes when discharge is 200 c.f.s.

Solution: $\frac{Q}{B} = 40$; $\frac{S}{B} = .30$; from nomogram $y_c = 2.75$ ft. The accuracy of the results may be readily checked from Eq. (4): For $y_c = 2.75$ ft., $T = 13.25$ ft., $A = 25.09$, sq. ft. $y_m = 1.89$ ft.

$V_c = 7.81$

$Q_c = 7.81 \times 25.09 = 195.95$ cfs.

A more accurate approximation for y_c may be obtained by computing the necessary change in depth, assuming no change in V_c.

$\Delta Q = 200 - 195.95 = 4.05$ cfs.

$$\Delta y = \frac{Q}{V_c\,T} = \frac{4.05}{7.81 \times 13.25} = .039 \text{ ft.}$$

The exact value of y_c will lie between the two results obtained and may be found by successive approximations to be 2.780 ft.

For values of $\frac{S}{B}$ less than .05, the equations for rectangular sections will usually give sufficiently accurate results. It might also be noted that in case the side slopes are not equal, S will be the average of the two side-slope values.

READER COMMENT

Sewage-Plant Costs

Sir: Prof. C. J. Velz's article, "How Much Should Sewage Treatment Cost?" (ENR Oct. 14, p. 85) involves a tremendous amount of painstaking effort.

Certain considerations, however, require further elucidation. Among these are:

STRUCTURAL ELEMENTS TO BE EXCLUDED FROM ESTIMATES. The writer, in compiling comparative cost data for new sewage treatment plants, finds the following structural elements—in addition to Velz's list—should be excluded: water, gas, and power services; unusual water systems; dikes; demolition; extra fencing; and covers for plant units—such as settling tanks, filters, and sludge-drying beds.

PERIOD COVERED BY THE ANALYSIS. Prof. Velz's analysis covers sewage plants built from 1920 to 1948. In this 25-yr. period, great progress was achieved in treatment processes. New plant units, various unit arrangements and capacities, different degrees of cleanliness for receiving streams, and extensive mechanization were introduced and perfected. As Imhoff and Fair state, "Construction costs depend chiefly upon the size of sewage and sludge tanks," (SEWAGE TREATMENT, 1940, p. 10, John Wiley and Sons, Inc.) so that plant construction costs varied with changing engineering tank design principles in the period.

More effective cost comparisons will result when the period of plant construction is limited to a few years. Cost comparisons could then be transposed to other periods by some applicable factors.

ENR CONSTRUCTION COST INDEX. It is questionable whether the ENR Construction Cost Index can be used accurately as cost transposing factor. An extensive analysis of the ENR index (PROCEEDINGS, ASCE, vol. 73, Jan. 1947, pp. 43-54) shows, that for non-building projects such as sewage treatment plants, the four index components—common labor, structural steel shapes, cement, and lumber—are not truly representative of constituent materials and labor.

CLASSIFICATION OF PLANTS BY TYPE, SIZE, AND LOCATION. Treatment plants should be classified according to type, size, and location for adequate comparison. Suggested size groupings are: 0-10 mgd.; 1-10 mgd.; 10-100 mgd.; and over 100 mgd.

In Prof. Velz's article, 48 plants (types not given) (26 percent) are 1.0 mgd. or smaller, and eighteen of these (types not given) (37 percent) are outside the 50 percent zone of the curves. Of 185 plants included on the chart, 60 (types not given) (32 percent) lie outside the 50 percent zone of the curves.

Filtration plants are listed in one group. Since high and standard-rate filters result in varying plant efficiencies and construction costs, it would be desirable to recognize this differentiation in the cost comparison.

Other cost data

Cost data on a number of large sewage treatment plants built between 1923 and 1930 (ENR index 200) are given by G. J. Schroepfer (PROCEEDINGS, ASCE, 1938, vol. 62, p. 742). Over 70 percent of these plants are located in states within Prof. Velz's area. After reducing Schroepfer's figures fifteen percent for engineering and contingencies and transposing to the 1926 ENR index of 208, the cost data prepared by the two authors are compared in Table 1.

A survey of sewage treatment projects needed in the United States (NATION-WIDE INVENTORY OF SANITATION NEEDS, U. S. Public Health Reports, April 1948) shows, that of 12,900 new plants needed, 90 and 61 percent of the plants would have capacities of less than 1.0 and 0.25 mgd., respectively. In Prof. Velz's analysis, 40 plants (22 percent) are over 10 mgd. in capacity.

Comparing disposal plants

A comparison of disposal plants by type as included in Velz's analysis, the NATION-WIDE INVENTORY OF SANITATION NEEDS, and 1945 survey of existing facilities in the United States (ENR Nov. 14, 1946, p. 112) is as follows:

Type of Treatment	Needed Plants Percent	Velz's Plants Percent	Existing Plants Percent
Primary	30	29	48
Secondary	5	12	3+
Complete	65	59	45

From incomplete studies of over 900 sewage treatment plants built in the United States under the Public Works Administration which have been screened to 110 new plants constructed in 1938 and 1939 and from Prof. Velz's analysis, the following deductions (based on Velz's computations) are made:

(1) Of 27 0.25-3.0 mgd. primary treatment plants in seven states of the Velz area, nine (33 percent) are outside the 50 percent zone of the Velz curves; of nine plants in the 0.25-1.0 mgd. group, four (44 percent) are outside the 50 percent zone; of seventeen projects (63 percent) in the 1.0-10 mgd. group, five (29 percent) are outside the 50 percent zone.

(2) Of fifteen trickling-filter plants in eight states of the Velz area, including two high-rate projects and four with covered filters, six (40 percent) are outside the 50 percent zone. Of eleven plants (73 percent) in the

TABLE I—A COMPARISON OF SEWAGE-TREATMENT CONSTRUCTION-COST ESTIMATES BY C. J. VELZ AND G. J. SCHROEPFER

Author	Type of Plant	Capacity 100 mgd.	Capacity 10 mgd.
Velz		47,300-64,000-86,500	75,000-100,000-138,000
Schroepfer	Primary (35 percent)	20,400	28,750
Velz	"	16,600-22,400-30,300	26,250-35,000-48,400
Schroepfer	Chemical (65 percent)	26,100	44,200
Velz	"	30,750-41,600-56,100	48,700-65,000-89,700
Schroepfer	Standard Filters (85 percent)	93,000	106,000
Velz	"	40,200-54,400-73,500	63,700-85,00-117,000
Schroepfer	High-Rate Filters (85 percent)	51,100	58,400
Schroepfer	Activated Sludge (90 percent)	61,100	70,800
Velz	"	42,600-57,500-77,800	67,500-90,000-124,000

0.09-1.0 mgd. group, four (36 percent) are outside the 50 percent zone. Of four plants in the 1.0-4.5 mgd. group, two (50 percent) are outside the 50 percent zone.

One high-rate filter plant in the 1.0-4.5 mgs. group is outside the zone while the other with less than 1.0 mgd. capacity is within the zone. Of the four covered filter plants, two are outside and two inside the 50 percent zone.

ISADOR W. MENDELSOHN
Sanitary Engineer
Washington, D. C.

No Index Reflects all Influences

Sir: It is gratifying to learn that Mr. Mendelsohn's data of costs of sewage-treatment works constructed under PWA during 1938-39 are in such close agreement with our cost curves. Of the 42 plants referred to by Mr. Mendelsohn in northeastern and central United States, 62 percent fall within our boundary curves expected to enclose 50 percent. Unfortunately Mr. Mendelsohn does not make his specific data available; but this high percentage indicates a close clustering about the central Most Probable Curve A. The agreement is closer than would be normally expected. Incidentally, the inference is that sewage-treatment design and construction under the PWA program was as economical or slightly better than the normal.

From the limited data available, we are unable to distinguish any segregation in cost as to type of plant, when referred to 100 percent efficiency basis. Mr. Mendelsohn's data likewise appear to confirm this, although his statement refers only to primary and trickling-filter works. A separate analysis of our data for 57 trickling-filter plants, in which there are no high-rate works, practically coincides with Curve A as published. From the present data there are strong indications that there is no segregation as to type.

Points of disagreement

Knowing Mr. Mendelsohn's discerning carefulness, we particularly appreciate the confirmation in his data. There are, however, some points of view upon which we are not in agreement. There can be little doubt that a strong relation exists between unit cost and plant size. Hence, each plant should be evaluated on the basis of its specific size and not by tenfold size ranges as suggested by Mr. Mendelsohn.

In reference to excluding structural elements, plant cost should not exclude what is essential as a functioning treatment system, and there should be a minimum of "doctoring" of the cost figures for true reflection of economy of design and actual experience. Our cost curves are not intended as a substitute for detailed engineers' estimates. Their primary purpose is to reflect actual practice and serve as a guide during development phase of pollution-abatement programs before plans are drawn.

Data are so few that restricting plant cost to a narrow period of years, in our opinion, will not increase accuracy. Costs vary considerably and only when data are sufficient in number can they be handled statistically to define reliable boundaries. We are unable to see from our data any progressive trend in costs with time or influences of mechanization of sewage plants.

Data is similar

The close agreement of Mr. Mendelsohn's own data for works built in a two-year period, 1938-1939, with our long-term data is a striking confirmation of this. It is, however, essential to consider the variations in general construction costs through the years and adjust cost from the year works are constructed to a common base year.

No index, furthermore, is entirely satisfactory nor can it be expected that any index will reflect all local cost influences. Miss Elsie Eaves (Manager, Business News Department of ENR) was the first to caution us on the limitations of ENR Construction Cost Index. We take full responsibility for using it on the grounds of its long and reliable record and that it is so well known and widely used in the engineering profession.

Mr. Mendelsohn makes comparison of our cost curves with Mr. Schroepfer's cost estimates. These data are not directly comparable. Mr. Schroepfer's cost estimates are synthetically built up from unit costs of hypothetical combinations of plant units, while our cost data are actual contract costs of works as designed and built. It would be more valuable to have the data on actual treatment works constructed, cost, size and year built, which Mr. Schroepfer so painstakingly collected.

More cost data needed

It is our earnest hope that ENR will continue to receive further specific cost data of actual works constructed to permit the continued analysis outlined in our first article on sewage-plant construction costs.

C. J. VELZ
Head, Civil Engineering Department and Professor of Sanitary Engineering
Manhattan College
New York, N. Y.

Old Buildings

Sir: The writer was interested in the article "Ancient Buildings in St. Augustine Reflect Good Design and Construction" on page 8 of the Nov. 4 issue, since he both visited and photographed all three structures some six years ago. As he recalls it, the dwelling was in particularly good condition, and as you say, well designed for its purpose.

He was told at the fort that the "coquina" occurred in natural beds which could be mined with a spade, but hardened quite rapidly on exposure to the air.

In regard to the old schoolhouse, the writer was informed at the time that it was supposed to be the oldest schoolhouse in America. If this is true, it must be considerably older than 200 years. The Vorleezer School House, in Staten Island, N. Y., is reported to have been built in the year 1695.

Incidentally, St. Augustine was one of the few "walled towns" on the North American continent. When the writer was in St. Augustine, the city gate towers were still standing very near the old schoolhouse, but he did not see any of the wall.

Quebec still has its gates and walls, some of the former being very beautiful, and Baltimore is reported to have had a timber wall around it in the early days.

KARL W. LEMCKE
Civil Engineer
New York, N. Y.

UNIT PRICES BID BY CONTRACTORS

Highway and Underpass, Roseville, California

OWNER: Department of Public Works, California; G. T. McCoy, State Highway Engineer.

PROJECT: Constructing 3.3 miles graded roadbeds paved with Portland cement concrete for a highway at Vernon and Grant Streets in Roseville to a point two miles north of the city. Constructing a railroad undergrade crossing under tracks of Southern Pacific Co.; constructing grade separation structures at Vernon St. and at Atlantic St. Improving the grades and alignment, and providing drainage facilities at Andora Underpass. Underpass to be a structural steel rolled beam bridge of two spans; the overcrossings, reinforced concrete slab bridges also of two spans.

CONDITIONS: All materials to be furnished by contractor. Access to job site is available by highway and rail. Prevailing hourly wage rates are: power shovel operators, $2.375 and $2.525; structural steel workers, $2.40; painters, $2.25; mechanical finishers (concrete or asphalt), $2.225; cement finishers and reinforced steel workers, $2.15; carpenters, $2.125; truck drivers, $1.525 to $1.9875; common labor on heavy construction, $1.425.

LIST OF BIDDERS: *Contract awarded October 19, 1948

1. *Guy F. Atkinson Co., So. San Francisco, Calif. $132,740.46
2. George Pollock Co., Sacramento, Calif. 153,234.25
3. Frederickson Bros., Emeryville, Calif. 158,405.18
4. Granite Const. Co., Watsonville, Calif. 200,000.00
5. United Concrete Pipe Corp. & John C. Grist & Ralph A. Bell, Baldwin Park, Calif. 200,000.00
6. Fredrickson & Watson Const. Co. & M. & K. Corp., Oakland, Calif. 250,000.00
7. Lord & Bishop & A. Teichert & Son, Inc., Sacramento, Calif. 250,000.00
8. Bates & Rogers Const. Corp., San Francisco, Calif. 300,000.00

	Item	Quantity	Unit Prices (1)*	(2)	(3)
1	Removing concrete	1,200 cy	$4.10	$6.00	$4.00
2	Clearing and grubbing	lump sum	9,500.00	10,000.00	6,000.00
3	Rdwy. excav.	187,500 cy	.39	.85	.75
4	Struc. excav. (major structures)	4,300 cy	1.50	2.50	3.50
5	Struc. backfill (major structures)	8,800 cy	2.00	3.00	3.50
6	Struc. excav.	7,700 cy	2.90	3.00	3.50
7	Ditch and channel excav.	1,200 cy	1.20	2.00	2.00
8	Compacting original ground	47,000 sy	.07	.10	.08
9	Overhaul	1,941 M sta y	.007	.01	.007
10	Imported borrow	57 M cy	.94	1.10	1.25
11	Preparing slopes (slope eras. prot.)	12,500 sy	.10	.10	.15
12	Mixing and compacting (cement treated subgrade)	22,200 sy	.35	.36	.32
13	Portland cement (cement treated subgrade)	875 bbls	4.25	4.45	4.20
14	Dev. wat. sup. and furn. wat. equip.	lump sum	5,000.00	15,000.00	4,500.00
15	Applying water	5,700 M gal	1.75	2.50	1.75
16	Finishing rdwy.	172 sta	20.00	13.50	25.00
17	Crusher run base	16,500 tons	2.70	2.60	3.00
18	Liquid asph., SC-2 (pr. ct. and pen. tr.)	105 tons	31.00	32.00	32.00
19	Sand (pr. ct., pen. tr. and curing sl.)	90 tons	6.00	4.95	4.75
20	Liquid asph., SC-6 (sl. ct.)	22 tons	31.00	40.00	35.00
21	Screenings (sl. ct.	300 tons	5.25	4.10	5.50
22	Liquid asph., RORC-5 (curing sl.)	35 tons	40.00	42.00	38.00
23	Asphaltic emulsion (pt. binder)	1 ton	60.00	60.00	55.00
24	Mineral aggregate (pl.-mix. surf.)	7,760 tons	4.30	4.15	3.70
25	Raised bars	100 lf	.70	1.50	1.25
26	Paving asph. (pl.-mix.-surf.)	390 tons	30.00	27.00	25.00
27	P. C. C. (pavement)	4,800 cy	15.50	16.00	16.00
28	Pavement tie bolt assemblies	3,500 ea	.60	.85	.50
29	Pavement-crossing devices, Type D	14 sec	90.00	250.00	180.00
30	Moving and resetting pavement-crossing devices	14 sec	30.00	50.00	85.00
31	Class "A" P. C. C. (structures)	8,200 cy	35.10	38.00	47.00
32	Rubber waterstops	1,235 lf	3.00	5.00	3.00
33	Furnishing structural steel	2,400 M lbs	.092	.11	.11
34	Furnishing structural silicon steel	65 M lbs	.095	.12	.12
35	Erecting structural steel	2,465 M lbs	.032	.025	.023
36	Structure railing	1,991 lf	12.00	15.00	14.50
37	Stair railing	2,700 lbs	.60	.65	.60
38	Miscellaneous steel	2,550 lbs	.40	.50	.60
39	Stairway safety tread	130 lf	2.20	4.00	4.00
40	Membrane waterproofing	3,000 sy	1.00	2.00	2.00
41	Protective covering	3,000 sy	1.00	1.50	1.25
42	Broken concrete riprap	170 cy	12.00	15.00	14.00
43	P. C. C. (curbs and gutters)	1,010 cy	35.00	27.00	40.00
44	P. C. C. (sidewalks)	465 cy	22.00	26.00	40.00
45	Monuments	70 ea	6.00	8.00	5.50
46	Metal plate guard railing	350 lf	3.00	3.00	3.50
47	Metal plate guard railing (barrier curb, Atlantic St.)	85 lf	6.00	3.00	4.00
48	Culvert markers and guide posts	85 ea	6.00	7.50	4.00
49	Chain link fence	2,232 lf	2.20	3.00	2.25
50	New property fence	3.8 mi	1,200.00	1,500.00	1,100.00
51	Drive gates	7 ea	50.00	50.00	45.00
52	Removing and reconstructing existing property fence	0.3 mi	1,200.00	1,000.00	1,050.00
53	12" R. C. P.	2,628 lf	2.80	2.50	3.30
54	15" R. C. P.	1,020 lf	3.80	3.00	4.35
55	18" R. C. P.	460 lf	4.50	3.75	4.45
56	24" R. C. P.	205 lf	5.50	6.00	6.00
57	30" R. C. P.	400 lf	8.20	7.00	8.60
58	36" R. C. P.	390 lf	11.00	9.00	12.50
59	48" R. C. P.	790 lf	14.00	15.00	18.50
60	4" Cast iron pipe	36 lf	9.00	3.00	3.50
61	4" Welded steel pipe (sidewalk drains)	44 lf	3.00	2.00	2.50
62	8" C. M. P. (16 ga.)	216 lf	1.75	2.00	2.75
63	12" C. M. P. (16 ga.)	130 lf	2.80	2.50	2.30
64	18" C. M. P. (16 ga.)	790 lf	3.60	3.25	3.30
65	24" C. M. P. (14 ga.)	160 lf	5.00	5.00	4.85
66	30" C. M. P. (14 ga.)	166 lf	6.00	6.00	6.10
67	42" C. M. P. (12 ga.)	176 lf	10.00	10.00	10.70
68	54" C. M. P. (12 ga.)	226 lf	13.50	15.00	16.50
69	60" C. M. P. (10 ga.)	76 lf	18.00	20.00	21.50
70	8" Perforated metal pipe underdrains (16 ga.)	130 lf	2.50	2.00	2.35
71	8" Perforated metal pipe underdrains (14 ga.)	5,220 lf	1.90	2.50	2.40
72	Filter material	745 cy	4.70	5.00	6.50
73	Spillway assemblies	6 ea	30.00	30.00	30.00
74	8" C. M. P. down drains (16 ga.)	190 lf	1.70	1.70	1.90
75	Salvaging existing pipe culverts	1,500 lf	1.20	2.00	1.75
76	18" Automatic drainage gate	1 ea	50.00	50.00	87.50
77	Salvaging drop inlet frames and covers	10 ea	25.00	25.00	12.00
78	Salvaging and reinstalling manhole frames and covers	8 ea	25.00	30.00	30.00
79	Cast steel frames and covers for drop inlets	29 ea	110.00	75.00	72.50
80	Cast iron frames and covers for manholes	5 ea	90.00	100.00	84.00
81	Drop inlets	51 ea	120.00	150.00	110.00
82	Manholes (Type J)	8 ea	140.00	300.00	200.00
83	Manholes (Types K & L)	5 ea	180.00	400.00	345.00
84	Cast steel frames and gratings (catch basins and storage box)	5,400 lbs	.35	.40	.37
85	Bar reinforcing steel	1,000,500 lbs	.095	.09	.09
86	Drainage pumping equipment	lump sum	7,200.00	5,000.00	3,000.00
87	Electrical equipment	lump sum	28,000.00	31,500.00	27,000.00
88	1" Galv. steel pipe (supply lines)	60 lf	.90	1.00	1.00
89	1½" Galv. steel pipe (supply lines)	430 lf	1.30	1.25	1.25
90	2" Galv. steel pipe (supply lines)	710 lf	1.70	1.70	1.75
91	2½" Galv. steel pipe (supply lines)	390 lf	2.20	2.20	2.20
92	Control assemblies	41 ea	25.00	35.00	30.00
93	¾" Galv. steel pipe (nozzle lines)	3,105 lf	.65	.70	.55
94	1" Galv. steel pipe (nozzle lines)	2,605 lf	.75	.75	.70
95	1¼" Galv. steel pipe (nozzle lines)	245 lf	1.10	1.00	.94
96	Rail barriers	lump sum	1,000.00	1,000.00	1,450.00
97	Red reflectors	14 ea	3.00	5.00	2.00
98	Traffic signals	lump sum	10,000.00	15,000.00	10,000.00

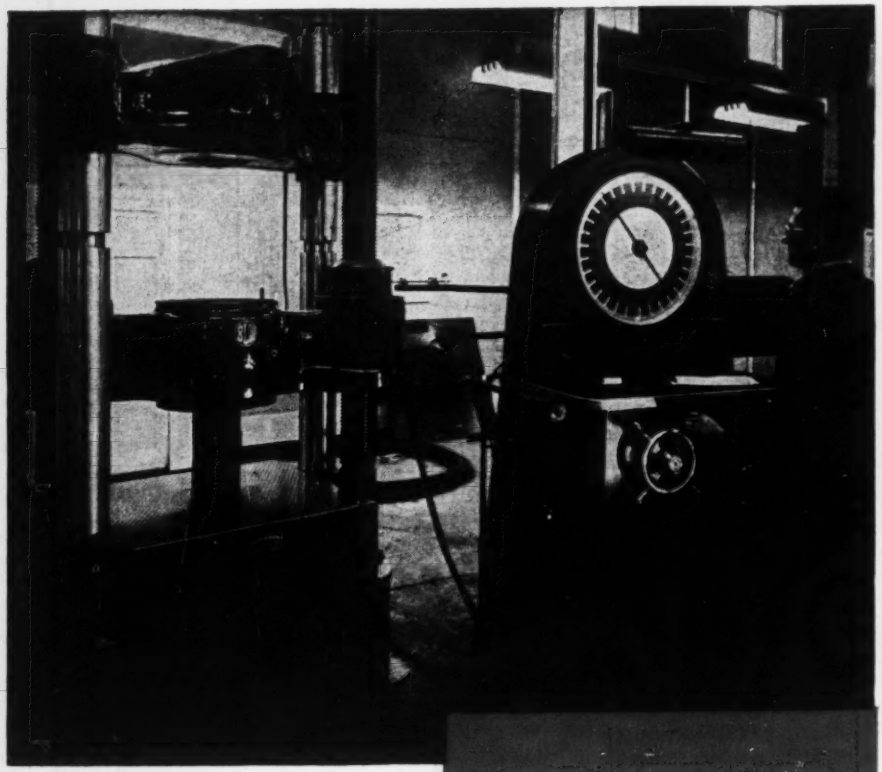
Reinforced Concrete Bridge, Indianapolis, Indiana

OWNER: State Highway Commission of Indiana; J. R. Cooper, engineer of bridges.

PROJECT: Construction of a five span, reinforced concrete arch. The dualtraffic lanes to be divided by a 4 foot center curb and bordered by 5 foot sidewalks. The piers and abutments to be carried on spread foundations supported on 2200 untreated timber piles. The structure will replace the present narrow bridge at West 16th Street over the White River in Indianapolis and will carry a total of 18,600 vehicles per day.

CONDITIONS: All plant labor and materials to be furnished by the contractor. Access to the job site is available by

Continued on page 89



ABOVE: Calibrating Testing Equipment at the Wharton Laboratory

ABOVE LEFT: Testing Concrete Cylinder for Compressive Strength

CONSTANT TESTING assures top quality

All materials used in the manufacture of Lock Joint Prestressed Concrete Cylinder Pipe are carefully tested to assure their uniformly high quality.

In Lock Joint's Laboratory at Wharton, New Jersey, accurately calibrated testing equipment checks the physical properties of all materials which constitute the finished product and test the physical characteristics of the completed pipe.

This constant check on all materials used in Lock Joint Pressure Pipe assures the top quality and long, useful service ot the finished product.

SCOPE OF SERVICES

Lock Joint Pipe Company specializes in the manufacture and installation of Reinforced Concrete Pressure Pipe for Water Supply and Distribution Mains in a wide range of diameters as well as Concrete Pipe of all types for Sanitary Sewers, Storm Drains, Culverts and Subaqueous Lines.

LOCK JOINT PIPE COMPANY

P.O. Box 269, East Orange, N.J.

Pressure Pipe Plants:
Wharton, N. J. • Turner, Kan.

BRANCH OFFICES:

Cheyenne, Wyo. . . . . Denver, Colo.
Kansas City, Mo. . . . . Joplin, Mo.
Valley Park, Mo. . . . . Chicago, Ill.
Rock Island, Ill. . . . . Wichita, Kan.
Kenilworth, N. J. . . . Hartford, Conn.

Reinforced Concrete Bridge, Indianapolis, Indiana

Continued from page 87

highway. Prevailing hourly wage rates in Indianapolis are: bricklayers, $2.40; structural ironworkers and welders, $2.33; carpenters, $2.18; painters, $2.00; cement finishers, $1.95; truck drivers, $1.43; and common labor for heavy construction, $1.20.

LIST OF BIDDERS: *Contract awarded September 16, 1948

1. *Smith & Johnson Inc., Indianapolis, Ind. $838,478.72
2. Traylor Bros. Inc., Evansville, Ind. 928,247.11
3. Rieth-Riley Constr. Co., Goshen, Ind. 973,660.97

	Item	Quantity	Unit Prices: Engineer's Estimate	(1)*	(2)
1	Class "D" concrete	2,694.2 cy	$60.00	$70.00	$60.00
2	Class "E" concrete above footings	2,694.7 cy	50.00	50.00	45.00
3	Class "E" concrete in footings	3,619.8 cy	45.00	35.00	35.00
5	Reinforcing steel	651,231 lb	.11	.12	.11
7	Timber piles furnished	45,300 lf	.75	.60	.65
8	Timber piles driven	36,240 lf	.65	.50	.75
9	Furnishing equipment for driving piles	lump sum	750.00	200.00	250.00
10	Cast iron	2,573 lb	.35	.30	.20
11	Wet excavation	14,976 cy	6.00	6.50	5.00
12	Waterway excavation	11,000 cy	.80	1.00	.75
15	Special filling material	17,650 cy	2.00	.50	2.00
21	Removal present structure (portion)	lump sum	10,000.00	8,000.00	19,000.00
23	Structural steel (handrail)	45,522	.35	.45	.50
24	Cofferdam—abutment no. 1	lump sum	12,000.00	15,500.00	32,000.00
25	Cofferdam—pier no. 2	lump sum	15,000.00	14,000.00	41,000.00
26	Cofferdam—pier no. 3	lump sum	15,000.00	15,300.00	41,000.00
27	Cofferdam—pier no. 4	lump sum	12,500.00	17,800.00	26,000.00
28	Cofferdam—pier no. 5	lump sum	12,500.00	14,500.00	26,000.00
29	Cofferdam—abutment no. 6	lump sum	11,000.00	15,500.00	32,000.00
30	6" Plain concrete pavement	1,619 sy	3.25	4.00	4.60
31	Pavement removal	1,242 sy	1.00	.60	1.10
32	Prewarning signs	12 ea	40.00	60.00	80.00
33	Std. barricades (type A)	1 ea	65.00	80.00	80.00
34	Class F concrete	166.8 cy	65.00	70.00	60.00
35	Handrails	42.8 cy	75.00	70.00	210.00
36	Placing 12" hand-laid riprap	515 sy	5.00	6.00	5.00

Roads, Highway Bridge and Streets, Fort Peck, Montana

OWNER: Department of the Army, Corps of Engineers, Fort Peck, Montana.

PROJECT: Construction of gravel-base and bituminous surfaced roads, a highway bridge and paving concrete curbs, gutters and walks at Fort Peck Dam Site on the Missouri River approximately nineteen miles southeast of Glasgow, Montana. Bridge to consist of 4 spans with concrete deck slab and steel I beam stringers. Work to include the realignment of the spillway west abutment cantilever wall, the installation of drainage structures, storm sewers, underground duct lines, railroad crossings and the replacing of existing wood guard rails.

CONDITIONS: The government will furnish cement and air entraining admixture, 28-inch dredge pipe, concrete aggregate, gravel materials, mineral aggregate, cover aggregate, and a concrete mixing plant with a capacity of 60 cubic yards per hour. All other plant labor and materials to be furnished by the contractor. The contractor will begin work within 30 days of notice to proceed and is to complete the project within 800 calendar days. Hourly wage rates are: bricklayers, $2.00; cement finishers, $1.50; structural ironworkers, $2.00; piledrivers, $1.50; concrete laborers and pipe fitters, $1.15; power equipment operators from $1.50 to $2.25; and truck drivers from $1.35 to $2.00.

LIST OF BIDDERS:

1. S. J. Groves Co., Minneapolis, Minn. $962,873.98
2. Fegles Const. Co., Ltd., Minneapolis, Minn. 1,404,420.90
3. Peter Kiewit Sons' Co., Sheridan, Wyo. 1,411,627.61
4. Northwestern Engineering Co., Rapid City, S. D. 1,419,819.80
5. S. Birch & Sons Const. Co., Great Falls, Mont. 1,438,554.39
6. McLaughlin Inc., Great Falls, Mont. 1,568,028.46

	Item	Quantity	Unit Prices: Gov't Estimate	(1)	(2)
1	Common Excavation	104,515 cy	$1.345	$ .60	$1.00
3	Borrow Excavation	4,188 cy	945	.60	1.00
4	Spot Sub-grade Reinforcement	1,120 cy	3.66	3.00	3.00
5	Water for Moistening	3,279 M gal	2.81	2.00	4.00
6	Additional Rolling				
	a. Sheepsfoot or Rubber-tired	500 rolr hr	6.79	6.00	8.00
	b. Power Rollers	800 rolr hr	7.44	6.00	8.00
7	Drainage Structures				
	a. Type "A"	11 ea	284.19	350.00	1,000.00
	b. Type "B"	8 ea	418.60	350.00	1,000.00
	c. Type "C"	12 ea	244.38	225.00	600.00
	d. Type "D"	1 ea	149.48	125.00	255.00
	e. Type "E"	2 ea	183.32	150.00	500.00
	f. Type "F"	2 ea	182.16	150.00	300.00
	g. Type "G"	1 ea	187.38	175.00	162.00
	h. Type "H"	1 ea	154.94	200.00	101.00
	i. Type "I"	1 ea	353.39	200.00	462.00
8	Concrete Walks	9,254 sy	3.70	2.75	5.00
9	Concrete Steps	3.5 cy	70.52	75.00	47.00
10	Concrete Driveways	1,561 sy	4.07	3.00	7.50
11	Reinforced Concrete Pavement	792 sy	3.76	3.00	8.25
12	Concrete Curbs and Gutters				
	a. Type "A"	935 lf	2.70	2.50	4.20
	b. Type "B"	337 lf	3.82	3.50	5.00
	c. Type "C"	100 lf	10.55	5.00	6.50
	d. Type "D"	830 lf	3.58	5.00	5.00
	e. Type "E"	1,010 lf	2.78	3.00	4.00
	f. Type "F"	700 lf	4.42	2.50	3.50
	g. Type "G-1"	31,712 lf	1.87	1.50	2.75
	h. Type "G-2"	4,050 lf	1.385	1.25	1.50
	i. Type "H"	1,900 lf	5.56	6.00	12.00
13	Concrete in Fort Peck Nashua-Highway Bridge	400 cy	63.46	80.00	130.00
14	Steel Reinforcement	100,516 lb	.127	.18	.15
15	Metal Fabric	13,500 lb	.195	.10	.15
16	Realignment of Spillway West Abutment Cantilver Wall	lump sum	17,486.70	43,102.00	40,000.00
17	Furnishing and Installing Wood Piling	2,628 lf	3.87	4.00	2.70
18	Installing Government-Furnished Wood Piling	4,748 lf	2.41	2.50	2.40
19	Furnishing and Installing 12" Corrugated Metal Pipe	78 lf	8.56	4.30	20.00
20	Furnishing and Installing 18" Corrugated Metal Pipe	344 lf	9.94	5.00	15.00
21	Furnish and Install 15" Storm Sewer	1,230 lf	9.30	5.25	15.00
22	Furnish and Install 12" Storm Sewer	2,096 lf	8.02	4.50	14.00
23	Furnish and Install 8" Storm Sewer	370 lf	4.41	3.25	6.00
24	Furnishing and Installing 3" Underground Duct Lines	963 lf	3.84	1.00	3.00
25	Installation of 28" Government Furnished Dredge Pipe	585 lf	3.49	3.00	10.00
26	Structural Steel in Fort Peck-Nashua Highway Bridge	240,000 lb	.218	.20	.20
27	Pipe Railing in Fort Peck-Nashua Highway Bridge	556 lf	6.08	10.00	10.00
28	Removal of Existing 24" Corrugated Metal Pipe	lump sum	280.28	500.00	100.00
29	Removal of Existing Walk and Gutter Slabs	361 sy	2.74	1.00	4.00
30	Removal of Existing Concrete Curb	652 lf	1.06	.50	3.00
31	Removal of Existing Concrete Drainage Structures	19 ea	78.62	75.00	200.00
33	Removal and Resetting of Existing Gates and Stockguard	lump sum	728.27	500.00	600.00
34	Removal, Salvaging and Resetting of Wood Guard Rail	lump sum	3,674.04	2,000.00	1,000.00
35	Removal of Existing Wood Curb	330 lf	.15	.50	1.00
36	Railroad Crossings	4 ea	395.30	360.00	500.00
37	Guide Posts	54 ea	16.85	10.00	15.00
38	Raising Piezometer Tube Roadway Boxes	lump sum	584.05	1,000.00	800.00
39	Preparation of Existing Base Course	247,870 sy	.177	.10	.17
40	Placing Base Course Material	75,410 ton	3.03	1.00	1.75
41	Placing Top Shoulder Course	8,770 ton	3.25	1.20	2.30
42	Placing Gravel Wearing Course	425 ton	2.79	1.60	2.50
43	Filler Material	8,335 ton	2.64	1.00	2.40
44	Bituminous Prime Coat, MC-0	120,000 gal	.255	.20	.20
45	Bituminous Surface Course, In Place	23,500 ton	5.58	4.00	6.20
46	Furnishing Mineral Aggregate for Bituminous Wearing Course	10,500 ton	4.82	2.50	2.40
47	Mineral Filler	492 ton	5.81	1.00	25.00
48	Asphaltic Cement, Grade 120-150	2,500 ton	53.85	45.00	46.00
49	Bituminous Seal Coat, RC-2	162,000 gal	.243	.20	.20
50	Placing Cover Aggregate	6,200 ton	3.22	2.50	3.50
51	Furnishing Cover Aggregate	2,700 ton	2.43	5.00	3.50
52	Removal of Exist Road Surf Mat	88,482 sy	.304	.10	.30
53	Remov of Exist Base Course Mat	52,960 sy	.63	.10	.30
54	Excavation for Gravel Base Extension	12,252 sy	1.11	.10	.35
55	Topsoiling	3,492 cy	1.85	2.00	2.00
56	Seeding				
	Type "A"	1 acre	625.00	250.00	150.00
	Type "B"	4 acre	865.00	200.00	150.00
57	Sodding	1,300 sy	4.45	1.00	1.75
58	Mowing	26 acre	55.20	10.00	25.00
59	Watering	520 M gal	10.28	5.00	10.00
60	Plugging Existing Drainage Structure—Type "A"	1 ea	38.52	100.00	25.00
61	Plugging Existing Drainage Structure—Type "B"	2 ea	25.00	100.00	50.00
62	Furnishing & Placing Steel Sheet Piling	2,560 sy	9.93	7.50	6.50
63	Furnish Base Course Aggregate	1,100 ton	5.59	2.50	3.60
64	Furnish Top Shoulder Course Aggregate	3,200 ton	5.26	2.50	3.00
65	Furnishing and Placing Pit Run Gravel	3,095 cy	3.85	5.00	3.00

Baffled BY CORROSION'S VICIOUS CIRCLE?

PROTECT *YOUR* PLANT WITH KOPPERS COATINGS!

CORROSION can easily create a vicious circle—a costly circle. To combat corrosion, Koppers makes 6 Industrial Protective Coatings—all specifically formulated to meet varying corrosive conditions.

For example, structures and equipment exposed to corrosive industrial fumes, underground or underwater installations, need the protection of Bitumastic* No. 50—the heavy-duty Koppers Coating. A different set of conditions may call for the use of Koppers Bituplastic* No. 28, or another one of our specialized coatings. In other words, each coating is specified in accordance with the nature of the individual corrosion problem. The result—*effective, lasting* protection of metal, masonry and concrete against corrosion and deterioration.

The ease of application and the long life of Koppers Protective Coatings hold maintenance expense to a minimum. Koppers representatives will gladly help you select the Koppers Coatings that will solve your plant's corrosion problems. Write us for further information. *Trade Mark Reg. U. S. Pat. Off

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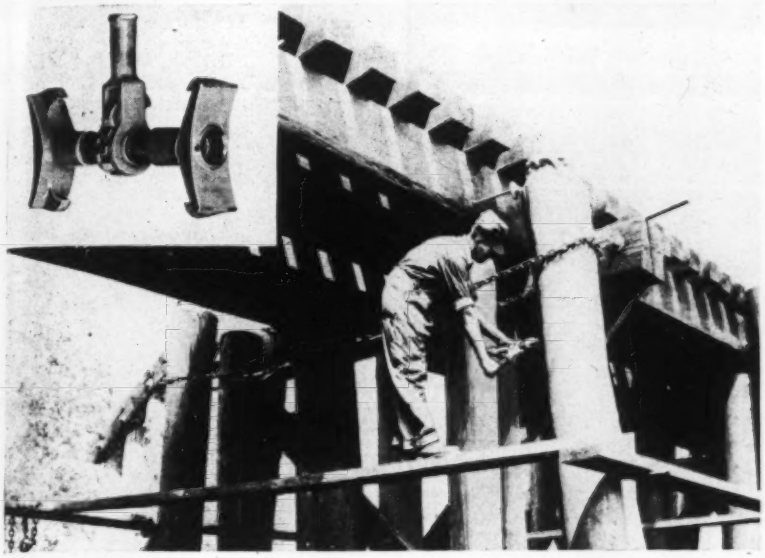
NEW PRODUCTS



Push and Pull Jacks

A new Cramer-type push-and-pull jack for safer and faster lining of piles, general heavy construction work, trestle bridges and all types of push and pull jacking jobs in construction. Available in two stock models, the jack reduces man-hours on the job. Its new design decreases the weight of the jack for easier portability and faster operation under conditions where ordinary jacks cannot be used. Machine V-edged nut protrusions assure a firm grip for pushing and save wear-and tear on piles. In addition, lugs offer a firm hold for chain on pulling jobs. All these factors help to maintain a rigidity so jack cannot slip. Ruggedly built, the jack features screws of precision-cut acme threads, thus lending greater strength. Model No. 5 is 11 in. in length (closed), extends to 17 in., and weighs 34 lb. Model No. 6 is 18 in. in length (closed), extends to 30 in., and weighs 42 lb. Both have a screw diameter of 1¾ in. and a rated capacity of 12 tons.—Templeton, Kenly & Co., 1020 S. Central Ave., Chicago 44.

Dozer Mounted Snow Plow

A new snow plow for use with the LeTourneau Model C Tournadozer has been developed. Made for heavy duty work, this "V" type plow has ample strength in the plow base, moldboards, and push-arm structures to enable it to break big drifts and move wet and frozen snow. Snow is lifted and flows with a minimum of resistance and without packing off the ends of the moldboards, the outer ends of which are curved outward to keep the snow from falling back into the road. The top of the blade is angled forward to prevent snow from drifting into the windshield. Fast acting cable operated controls permit raising the plow 5½ ft. to handle high bank jobs. Three adjustable steel runner shoes permit the plow to be nosed up or down, or adjusted for cutting height. A large divider plate built into the nose of the plow prevents the snow from being plowed back into the road on widening jobs.—R. G. LeTourneau, Inc., Peoria, Ill.

Architectural Shapes

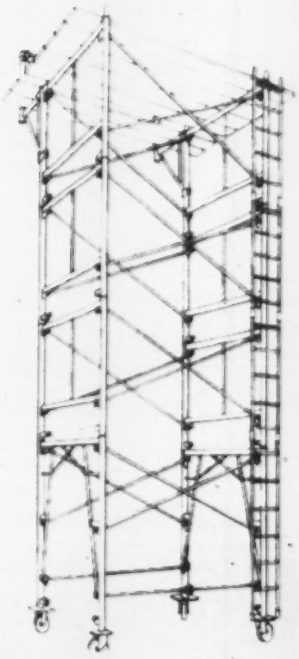
Standard architectural shapes in extruded aluminum now available from this manufacturer include thresholds, window sills, jambs, mouldings and stools, handrails with balusters, base mouldings, copings, exterior facing, and gravel stops.—Reynolds Metals Co., 2500 So. Third St., Louisville, Ky.

Redesigned Model YU

FWD's Model YU truck has been redesigned and re-engineered to provide greater driver comfort, ease of driving, serviceability and adaptability to a wide variety of applications. It is equipped with a 5-6 yd. dump body for highway hauling work. A feature is the all steel safety cab. Greater visibility is provided in the design of the door and rear cab windows and the windshield. The flick of a switch on the dashboard locks the differential, providing positive power to both front and rear axles for climbing steep hills or plowing through mud or sand. This new model YU is adaptable to a number of specialized heavy duty truck applications. The company expects its major use to be in the fleets of state, county and municipal street departments.—The Four Wheel Drive Auto Co., Clintonville, Wis.

Snow Loader

Utility model features spiral feed with renewable steel teeth and with capacities from 8 to 20 cu. yd. per min. Powered by 27-hp. LeRoi four cylinder engine. Has deep-trough boom with complete hydraulic control, swivel discharge spout controlled through 160 deg. from operator's platform. Loader is self-propelled and one-man operated. Has two speeds forward and two reverse. Elevator clutch has automatic overload release to prevent damage to machine. A bucket boom is available separately to convert the chassis into a loader for handling such heavier materials as sand, earth, gravel or broken stone.—N. P. Nelson Iron Works, Inc., Clifton, N. J.



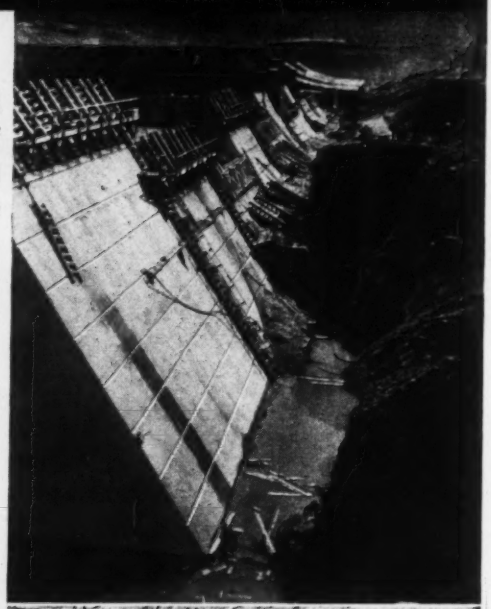
Tubular Steel Scaffold

Production is about to start on an improved tubular steel knock-down scaffold to be called the "Advance." Frames are double welded at the girt points and the joining cross braces have a cam lock for fast and positive assembly as well as rapid knock-down. There are only 15 different parts in all. Scaffold is engineered for a load of 50 lb. per sq. ft. on 7-ft. spans, at a height of 125 ft. with a safety factor of four.—Beaver Art Metal Corp., Ellwood City, Pa.

BLAW-KNOX

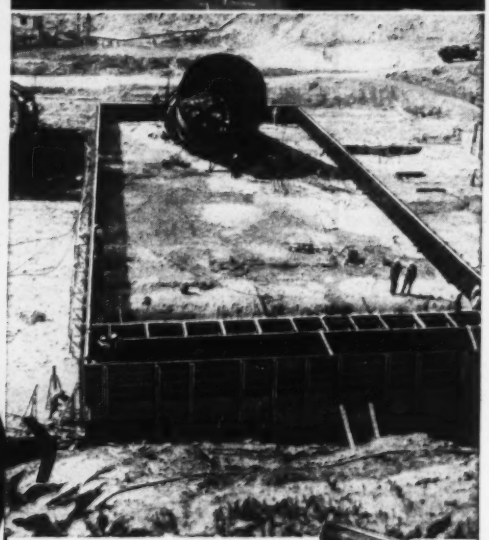
applies its STEEL FORM *"Know How"*

TO CONCRETE GRAVITY DAMS



Blaw-Knox has proved the practicability of its forming method for pouring concrete monoliths of gravity type dams—a design of steel form which is easily handled through successive lifts—and which can easily be aligned for all job conditions.

It would be our pleasure to tell you about this tried and proved system of BLAW-KNOX STEEL FORMS for concrete monoliths. You will incur no obligation by asking for this information.



This accurate alignment is quickly achieved by mechanized adjustment.

Blaw-Knox STEEL FORMS have been serving engineers and contractors for over 40 years. The Blaw-Knox record of accomplishment is shown in Catalog 1836. Send for a copy.

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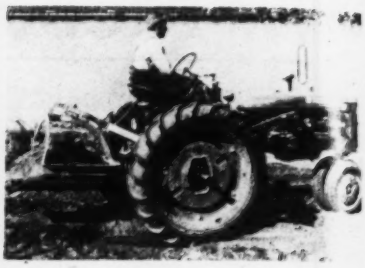


Hydro-Scoop

A special hitch for the Stockland Hydro-Scoop, a reversible rear end power shovel for hydraulically equipped tractors, now adapts it to fit International's new model C tractor. The hitch makes it easy for the operator to mount or dismount the scoop without removing the drawbar. The Hydro-Scoop is a 10-cu.-ft. shovel that uses hydraulic power to scoop or shovel, lift, carry and dump earth and other bulky products. The reversible feature makes it easy to get the shovel in close to buildings, fences, stock piles, banks or dropoffs. Loads can be dumped in a pile or spread and leveled as the conditions require. The shovel takes a bite 24 in. deep in such materials as dirt, coal, sawdust, sand, snow, and refuse.—Stockland Road Machinery Co., 2653 Thirty-fourth Ave., So., Minneapolis 6, Minn.

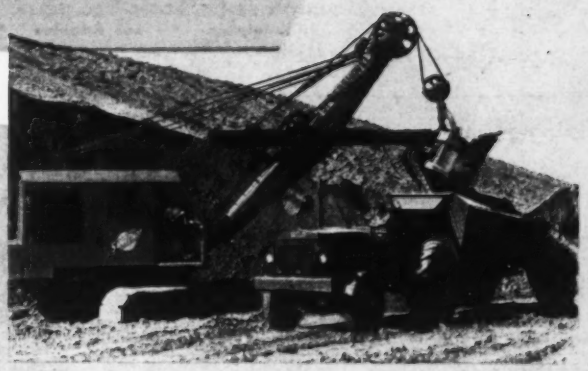
Replaceable Bit Rooter

Ditchers can operate more efficiently if the rooters or teeth on the digging buckets are kept sharp. The Quick-Change Rooter Bit consists of two members, a holder which is bolted to the bucket and a removable bit which can be replaced readily when worn. It is only necessary to hammer new bits into the holder. A wedge-shaped socket or cavity in the holder receives a corresponding shank in the bit. This shank has a V-spline which holds once it is driven into the socket. No bolts, keys or special tools are required. To remove the worn bit a drift pin is placed in a slot in the bit holder and a sharp blow on the pin is applied with a hammer. The bit pops out.—Gar Wood Industries, Inc., Findlay Division, Findlay, Ohio.

"GULF QUALITY LUBRICANTS

smooth the way to greater yardage"

says this Contractor*



* Bero Engineering & Construction Co., Buffalo, N. Y., is rebuilding New York State Highway #8 between South New Berlin and New Berlin, Chenango and Otsego Counties, N. Y.

"Gulf quality lubricants have helped us get outstanding service from our equipment over a period of years," says this prominent New York Contractor. "On every job, we get the kind of lubrication that means smooth operation and freedom from serious mechanical delays—which add up to greater yardage and lower maintenance costs."

Bero Engineering & Construction Co. is one of scores of leading contractors who have found that Gulf quality lubricants provide an extra margin of protection to equipment, particularly when it is pushed hard to beat contract schedules. And Gulf makes available a corps of trained lubrication engineers to assure the most suitable lubricants for every unit and operating condition.

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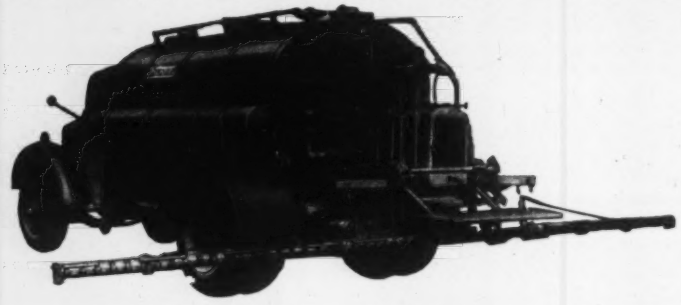

FOR BUILDING NEW ROADS
FOR MAKING OLD ROADS LIKE NEW

For almost forty years Kinney has produced Bituminous Distributors for modern road construction. Today, Kinney Distributors, with their famous positive displacement Rotating Plunger Pumps, are the recognized standard for applying all grades of bitumen in building roads, highways, and airports. Engineers know they can rely on Kinney Distributors to apply a uniform amount of bitumen across the full width of the road — *as accurately as a meter.* Operators find these units easy to manage. Convenient controls provide for exact matching of strips, quick starting and stopping, plus thorough cleaning and flushing of lines and spray bars.

Investigate the advantages of Kinney Distributors for modernizing old roads or for building new roads. Write for the new Bulletin A-48.

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3527 WASHINGTON STREET, BOSTON 30, MASS.
New York • Chicago • Philadelphia • Los Angeles • San Francisco
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Hayward Buckets

Use this Class "E" Clam Shell Bucket for handling crushed stone, gravel, sand and other bulk materials.
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38 YEARS INSTALLING PILES
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CAST-IN-PLACE CONCRETE COMPOSITE
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SOIL AND ROCK BORINGS

MacARTHUR CONCRETE PILE CORPORATION
18 EAST 48th STREET, NEW YORK 17, N. Y.
BOSTON • CINCINNATI • NEW ORLEANS

Manufacturers' Publications

Snow Loader — Utility and heavy duty models of snow loaders, featuring spiral feed with renewable steel teeth, and with capacities of from 8 to 30 cu. yd. a minute are described and illustrated in a new bulletin.—N. P. Nelson Iron Works, Inc., Clifton, N. J.

Rolling Doors—An 8-page catalog covers rolling grilles, sliding grilles, rigid and folding upward-acting doors in wood and steel. Grilles are also made of aluminum, bronze and stainless steel. —Cornell Iron Works, Inc., 36th Ave. & 13th St., Long Island City 6, N. Y.

Corrosion-Resistant Concrete — A new booklet on Lumnite tells of corrosion-resistant concrete. It covers both the methods and materials used in placing corrosion-resistant concrete in a wide variety of industrial applications. In addition to floor applications, corrosion-resistant concrete is being successfully used in lining stacks, oil refinery vessels and drainage systems.—Lumnite Division of Universal Atlas Cement Co., 135 East 42nd Street, New York 17, N. Y.

Calcium Chloride Effects — A 40 page semi-technical booklet, of interest to engineers and others concerned with specifications, design or production of Portland Cement concrete, has been issued. It condenses from research and technical reports the effects of adding measured quantities of calcium chloride to Portland Cement mixes. It contains tables, graphs and charts covering setting time, early strength, curing, slump, density, surface wear, shrinkage, and ultimate strength. Also shown are effects of varying temperatures and cold weather, and the results with special cements including air entraining, high early strength, and low heat cements.—Solvay Sales Division, Allied Chemical & Dye Corp., 40 Rector Street, New York 6, N. Y.

Water Conditioning—Executives and engineers concerned with the treatment of water for steam generation, process work or general plant services will be interested in a brochure about Liquon equipment and Liquonex materials for all liquid conditioning processes. It outlines the background, facilities, and processes and equipment offered in the fields of water treatment and conditioning of other liquids. In-

cluded in it are references to more than 50 technical articles covering developments in these fields.

The brochure also contains illustrations of plant facilities and installations of various types of LIQUON equipment. — LIQUID CONDITIONING CORP., 114 East Price Street, Linden, N. J.

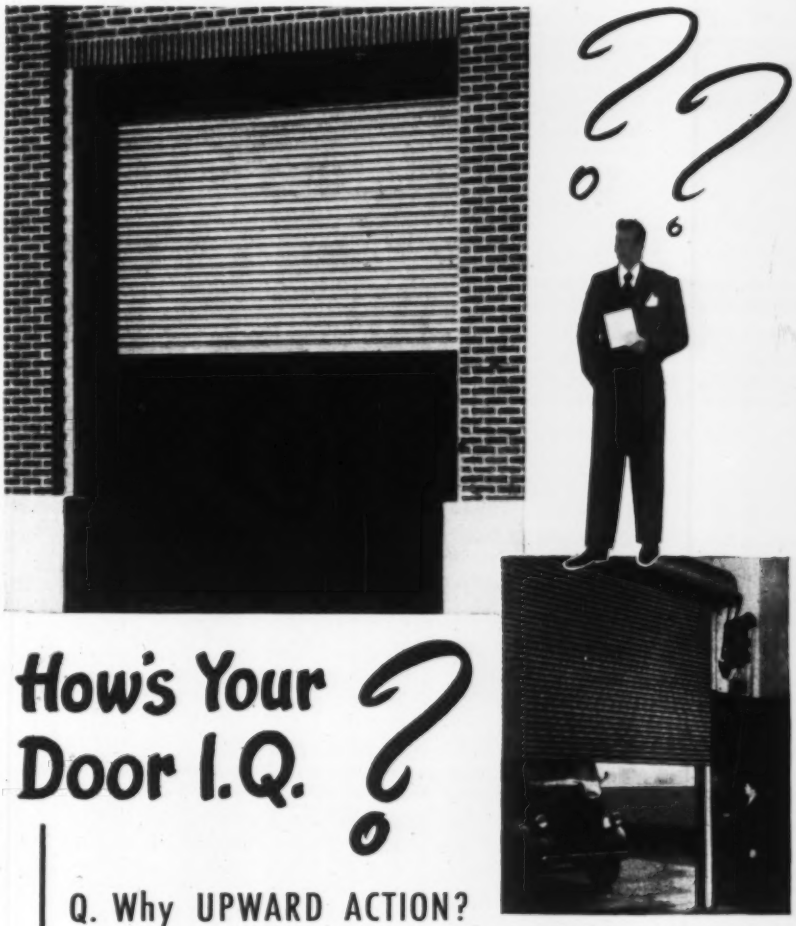
Fiberglas—A handsome booklet presents products of Fiberglas as applied or displayed in the new office building of—OWENS-CORNING FIBERGLAS CORP., 16 East 56th St., New York, N. Y.

Heavy Duty Flooring—A bulletin gives an account of the experience of the N. Y. Central R. R. System with heavy-duty Emery flooring on freight platforms made with Cortland Emery aggregate. Facts are given about weight and type of traffic passing over outdoor freight platforms, use of salt and other chemicals to keep clear of ice, without ill effect, and photographic illustrations of conditions under which Emericrete floors operate.—WALTER MAGUIRE CO., INC., 330 W. 42nd St., New York 18, N. Y.

Snow Removal—An 8-page folder, based on a 15-minute 16 mm. sound and color movie, "Modern Snow Removal by Haiss," is now available. It summarizes the story of the movie, which describes the performance of Haiss snow loaders—Model 75 WS (wheel mounted), Model 75 CS (crawler mounted) and Model 300 WS-SBC (equipped with swivel belt conveyor). Typical scenes show the difference between hand shoveling and snow removal by Haiss in a number of cities. The film is available now for free showings —GEORGE HAISS MFG. CO., INC., division of Pettibone Mulliken Corp., 141st to 144th St. on Park Ave., New York 51, N. Y.

Road Computator—A handy pocket-sized, specially designed slide rule quickly determines bitumeter or tachometer settings for all rates of distribution with spray bar lengths of from 3 ft. to 30 ft.; binder material required for application of from ¼ in. to 4 in. in depth. The device also can be used to solve any multiplication, division or percentage problem.—E. D. ETNYRE & Co., Oregon. Ill.

Hard Facing Alloys—Bulletin tells of Stoody products to provide increased wear-resistance, faster deposition and better weldability if hard facing materials—designed primarily for hard-facing crushers, shovels, tractor parts, dredges, materials handling and heavy construction equipment—STOODY CO., Whittier, Calif.



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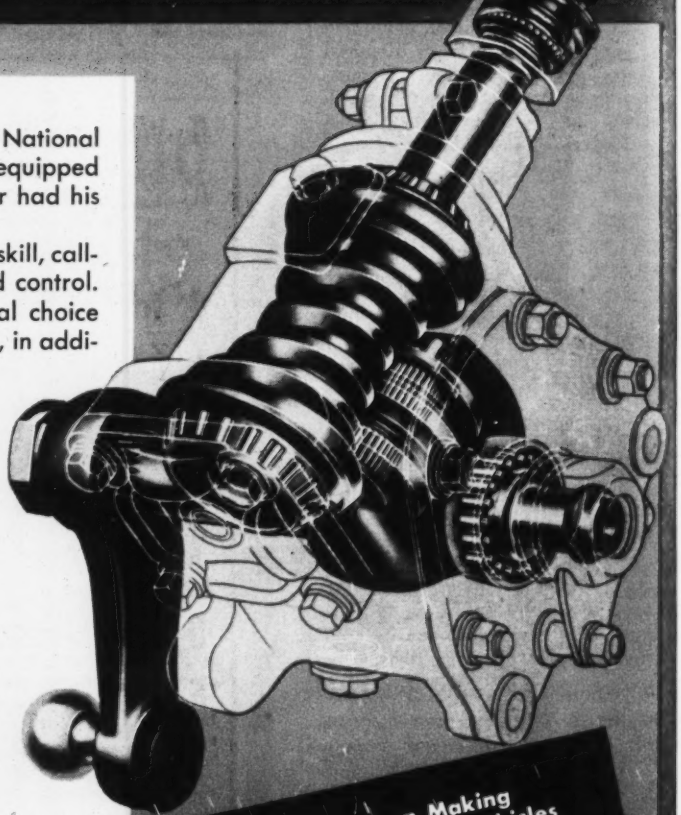
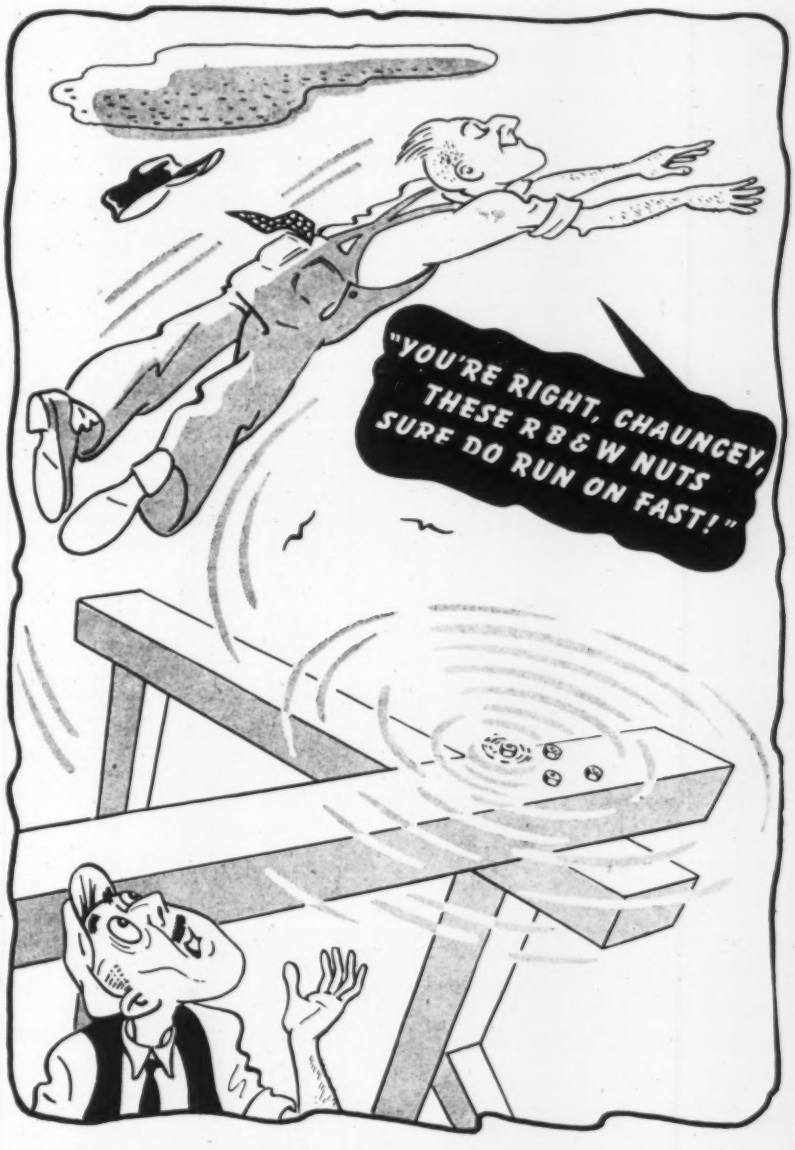


Gemmer Has Been Making Steering Gears for Motor Vehicles for 42 Years

Manufacturers' Activities

Sales—Charles L. Peyton is sales manager for the Illinois-Wisconsin district of the UNIVERSAL ATLAS CEMENT Co. at Chicago . . . Robt. M. Hays is sales manager of the trailer axle division of the TIMKEN-DETROIT AXLE CO. . . . J. C. Barnes is vice-president for sales, eastern division, the RITTLING CORP., Buffalo, N. Y., heating equipment. . . . Lewis B. Kinney is sales representative in Colorado for BABCOCK & WILCOX TUBE CO., Beaver Falls, Pa. . . . D. J. Byrd is district manager in the southeast region for GAR WOOD INDUSTRIES, INC. of Wayne, Mich. . . . Lionel Tinfow, sales engineer, has been added to the staff of the New York branch office of the PENNSYLVANIA FLEXIBLE METALLIC TUBING CO. . . . Henry F. Munroe has been added to the sales engineering staff of % Proportioneers, Inc. % of Providence, R. I. . . . R. Fred Moore is in the sales department of GOODYEAR YELLOW PINE CO., Picayune, Miss. . . . GENERAL TIRE & RUBBER CO. has opened a new branch sales outlet at Richmond, Va. . . . McMillan Robinson has been appointed sales manager for the metal products division of KOPPERS CO., INC. . . . Frank W. Eichman is sales manager of the Philadelphia plant of JOSEPH T. RYERSON & SON, INC., steel distributors . . . Dale S. Gronsdahl will serve the sales department of CATERPILLAR TRACTOR CO. in Alabama, west Florida and central Tennessee . . . Walter W. Harvey and Conrad P. Herman are the new heads of sales for the FOSTER TRAILER CO., Los Angeles . . . James J. Flasco is St. Louis branch sales manager for the GENERAL TIRE & RUBBER CO. . . . A meeting of the Southeastern district sales representatives of the A. B. FARQUHAR CO., of York, Pa., was held recently in Atlanta, Ga. . . . Ralph O. Wirtemburg has special assignments from the general sales manager's office of the NEW DEPARTURE DIV., GENERAL MOTORS CORP.; James P. Gillilan succeeds Mr. Wirtemburg as eastern regional manager; and C. S. Fleet fills Mr. Gillilan's former place . . . New sales representatives of ALLIS-CHALMERS are J. I. Onarheim and R. T. Ward, Milwaukee; Joy Seefeld, San Antonio, Tex., W. H. Sanford, Houston, Tex.; A. J. Mestier, Jr., New York; and R. E. Bender, Grand Rapids, Mich. . . . James A. Anderson is assistant sales manager of BABCOCK & WILCOX TUBE CO., and Wm. H. Buley is manager of stainless sales. . . . John E. Wells is special rules representative of Industrial Parts Div. of REYNOLDS METALS CO.



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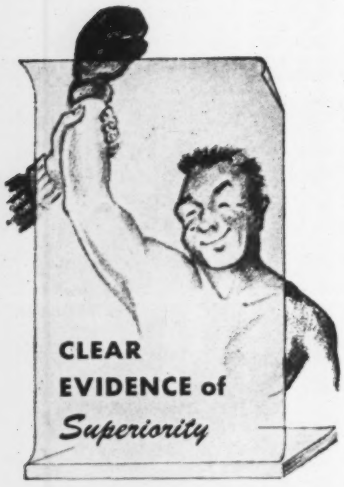

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Distributors—E. A. Altshuler, 1605 Cahuenga Blvd., Los Angeles, will set up distributors in the West for PREST-GLASS CORP., New York . . . WILHELM-DAVIS CO., INC., Wallingford, Conn., has been appointed distributor in Connecticut for BARBER-GREENE CO. . . . Thurston Cooke Equipment Co., Louisville, Ky., is a Class A dealer for DAVEY COMPRESSOR CO., Kent, Ohio. . . . MILLER, BRADFORD & RISBERG CO., INC., Eau Claire, Wis., are distributors for R. G. LE TOURNEAU, INC., for Wisconsin except for the 11 Northwestern counties . . . John C. Riley, Jr., 407 Scanlon Bldg., Houston, Tex., is district representative for MIDVALE CO., Philadelphia; the READING CHAIN & BLOCK CORP., Reading, Pa., DIAMOND SAW WORKS, Buffalo, N. Y.; ARROW PRODUCTS, Grand Rapids, Mich.; the PHOSPHOR BRONZE CORP., Philadelphia; ELECTRIC STEEL FOUNDRY CO., Houston, Tex., and Portland, Ore. . . . and HASCO VALVE and MACHINE CO., Milwaukee, Wis. . . . Within a period of six months M. R. Hamill, distributor for HUBER MFG. CO. at Charleston, W. Va., sold 55 Huber road mainteners to the West Virginia State Road Commission.

Personalities—W. E. Toensing is district manager for GAR WOOD INDUSTRIES, INC., in Virginia, N. C., S. C. and the D. C. . . . A. W. Wagner is general parts division manager for THE THEW SHOVEL CO. . . . R. S. Rankin, assistant manager of North American sales for THE DORR CO., in charge of sanitary engineering work, is in Europe for three months inspecting sewage and water treatment plants and conferring with his company's associates in London, Amsterdam, Brussels, Paris and Milan . . . Thomas J. Tingle is western division manager in charge of manufacturing for TAYLOR FORGE & PIPE WORKS, Chicago, at the New Fontana, Calif., plant . . . David S. Day, sales manager, Duluth, Minn., has retired after 41 years of continuous service with UNIVERSAL ATLAS CEMENT CO. . . . Joseph M. Tucker, formerly executive vice-president of the MARSEY-HARRIS CO., Racine, Wis., will become executive vice-president of the LUSTRON CO. . . . Geo. Carlson is manager of manufacturing for the conduit products division, GENERAL ELECTRIC CO.'s construction materials department; Robt. L. Wakelee is materials manager of that division, and G. H. Howes is supervisor of general accounting . . . Daniel J. Boone is manager of the general merchandising division of the ZONOLITE CO., Chicago . . . W. E. Madden is vice-president of the GEORGE HAISS MFG. CO., INC., New York City . . . Robt. E. Bounds is staff engineer with the insulations division of THE PARAFFINE COMPANIES, INC., San Francisco . . . Roy E. Smith is president of STEFCO STEEL CO., INC., Michigan City, Ind.

Deceased—Edward W. Ashmead, 59, assistant to the general manager of the ALABAMA POWER CO., died in Birmingham Nov. 29 . . . Clarence L. Wiggins, Sr., 64, vice-president and general manager of the GULF LUMBER CO., Mobile, Ala., died Dec. 2 . . . L. O. Crosby, Sr., 79, president of the GOODYEAR YELLOW PINE LUMBER CO., Picayune, Miss., died Nov. 24 . . . Frank Hill, 40, sales manager of the Wichita, Kan., branch of the REYNOLDS METALS CO., died Nov. 19 . . . Vincent McCarthy, for many years district sales manager for R. D. WOOD CO., Philadelphia, Pa., died in Lakewood, Ohio, Nov. 8 . . . F. L. Jaeger, 70, retired vice-president of the MARQUETTE CEMENT MFG. CO., Chicago, died Nov. 15. An employee for over 30 years . . . Thomas R. Mullen, Jr., 28, Brooklyn, N. Y., vice-president of LEHIGH STRUCTURAL STEEL CO., Allentown, Pa., died at Salem, Mass., Nov. 16.

Miscellany—THOMAS CRIMMINS CONTRACTING CO., New York, recently celebrated the 100th anniversary of its founding . . . BINGHAM-HERBRAND CORP., has opened one new divisional office at 551 Fifth Ave., New York City, and another at 2500 West 6th St., Los Angeles . . . TIMBER STRUCTURES, INC., has former TIMBER STRUCTURES, INC., of CALIFORNIA at Oakland to serve northern California and Nevada with highway bridges, roof trusses, glued laminated arches, building frames and package buildings, and miscellaneous fabricated items. Frank Benson is the manager and MacGregor Graham the sales manager. T. C. Combs, the former manager, will become vice-president in charge of sales at the Portland, Ore., office. C. H. Anderson has been appointed chief engineer, and J. A. Finelli is production manager . . . The PRELOAD CORP. has removed its office to 211 E. 37th St., New York, 16, N. Y. . . . AIRQUIPMENT CO. has bought AEROL CO., INC., which will continue as a subsidiary . . . EPPINGER AND RUSSELL CO. wood preservers, 80 Eighth Ave., New York City, has acquired the wood preserving plant of the KEYSTONE WOOD PRESERVING CO., of Eddington, Pa. . . . TWIN DISC CLUTCH CO., Racine, Wis., has built a new building for its Seattle branch sales engineering office at 1214 Westlake Ave., North, Seattle, Wash. . . . MANHATTAN RUBBER DIVISION of RAYBESTOS-MANHATTAN, INC., recently completed its 55th year . . . GENERAL ELECTRIC on Nov. 18 opened a new $3,000,000 plant in San Jose, Calif., to produce 5- to 500-hp polyphase motors for irrigation pumps along with single-phase integral horsepower motors. Peak production of 1,500 motors per week is

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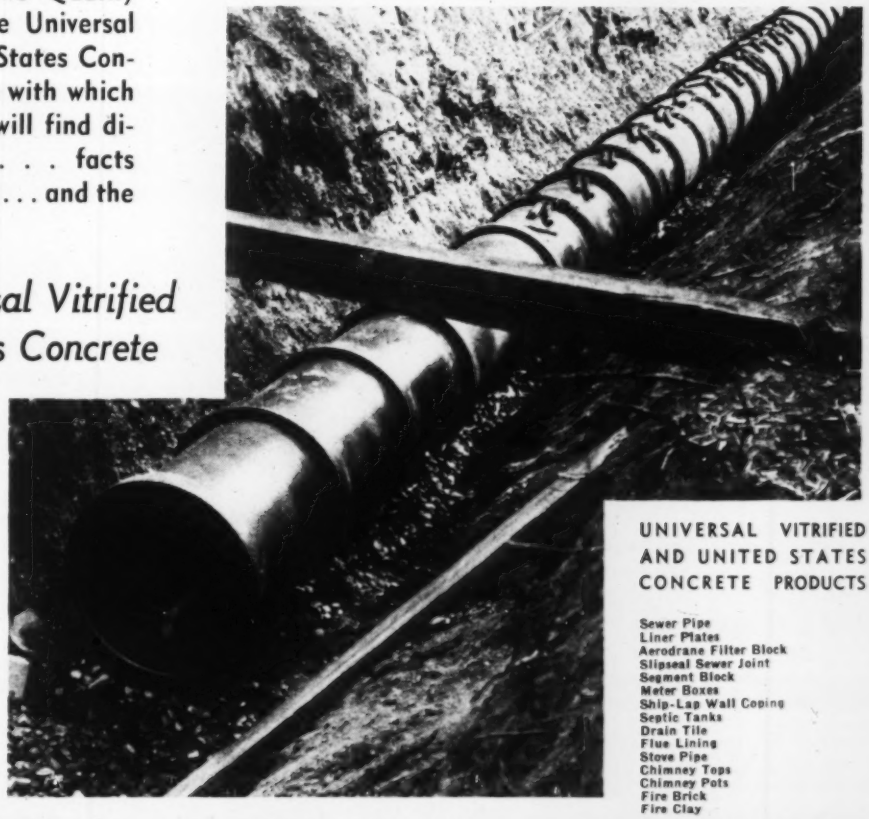

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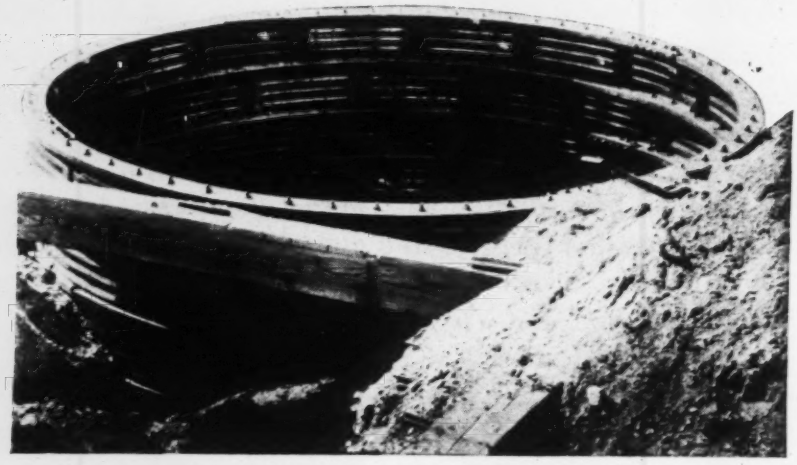

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expected soon . . . Trustees of the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, are sponsoring awards to bridge or structural engineers for the best designs of a specified welded highway bridge. First award, $3,000; second, $1,500; third, $750. There will also be ten honorable mentions. Competition opens Jan. 1, 1949, and closes June 30, 1949. Any engineer or designer is eligible.

Elections and Activities

Frank Corace has been elected president of the Home Builders' Association of Allegheny County, Pa. Other officers are: Felix Caste and Fred Favo, vice-presidents; W. B. Dixon, Jr., treasurer; and Eugene Cassidy, secretary. Mr. Corace is president of Baldwin Homes, Inc.

The 963d Engineer Construction Battalion of the Army Reserve, sponsored by the Associated General Contractors of America, Cleveland, Ohio, has been organized, and Lieut. Col. James R. Fraser has assumed command. The unit, first of its kind to be formed in Cleveland, has an authorized complement of 44 officers and 900 enlisted men. Its primary military mission will be construction of roads, bridges and buildings in support of combat units. Maj. Leon Albin will be Army instructor for the unit. The administrator of the organized reserve corps, with headquarters in Cleveland, will be responsible for the administration of the new unit and supervise its training.

Sponsored by the Kentucky Highway Division of the Associated Contractors of America, another Army reserve unit has been formed at Louisville. Created for "rapid Army expansion in the event of an emergency," the unit, composed largely of contractors, will be known as the 364th Engineer Construction Group. Lt. Col. Herman A. Erhart, is commander of the new group, which will drill once a month. Maj. Robert R. Dawson, Bloomfield, is the executive officer.

Arizona Building Contractors, Inc., at its first annual meeting at Phoenix elected officers and adopted resolutions dealing with the financial side of the contracting business. They asked tighter controls on issuing contractors' licenses, a cut from 25 to 10 percent of the amount contractors must deposit for satisfactory completion of public works

and a cut from 3½ to 2 percent in the sales tax on construction, which contractors noted had to be passed on to the builder.

F. H. Chapman, formerly of Trail, has been appointed permanent secretary of the Association of Professional Engineers of British Columbia. A graduate of Queens University, he has been with the Consolidated Mining and Smelting Co. for 22 years as research engineer. He has been technical advisor in smoke litigation proceedings.

Lt. Col. Walter L. Meyer, Lincoln, Neb., will command the new 314th engineer construction group sponsored by the Nebraska building chapter of the Associated General Contractors of America, Inc.

T. M. S. Kingston, city engineer of Chatham, Ont., was elected president of the Canadian Institute on Sewage and Sanitation at the recent annual convention. He succeeds G. Harry Richards, city engineer of Brantford, Ont. L. G. McNeice, of Orillia, Ont., was elected vice-president and A. E. Berry continues as secretary-treasurer. Dr. Berry is director of the sanitary engineering division of the Ontario Department of Health.

At the recent joint meeting of the W. Va. section of the AWWA and the W. Va. Sewage and Industrial Waste Association, a field trip was made through the plant of the Universal Concrete Pipe Co. at Clarksburg to see how concrete pipe is made.

Arrangements were made by Earl W. Chidester, Universal's plant manager, and Sam Buderman, Wheeling, W. Va., West Virginia sales manager. Some of the displays were:

Forty-eight inch full circle clay lined, extra strength reinforced concrete pipe with Rexon coating and Basalit joint compound. This pipe was manufactured for the Weirton Steel Co., Weirton, W. Va.

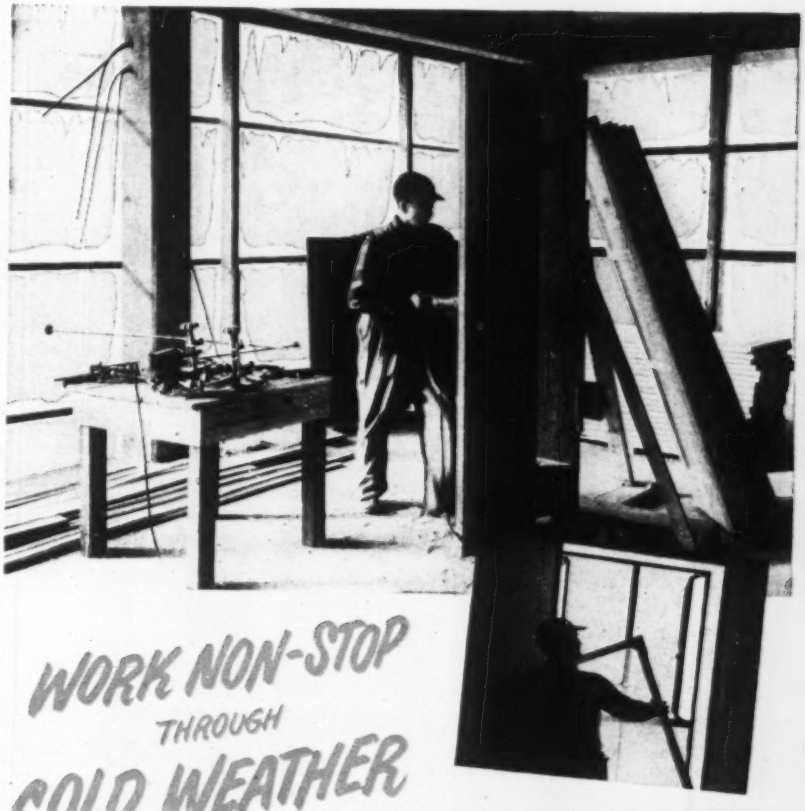
Eighteen-inch three-foot vitrified clay ring inserted in 24-inch reinforced concrete pipe.

Twelve-inch reinforced concrete pipe coated on the internal and external with Texon, a synthetic rubber compound.

Fifty-four inch slanted precast concrete manholes.

Water meter walls, water pressure pipe and regular sewer pipe.

E. E. Gamet, of Slater, has been elected president of the Missouri Water and Sewage Conference; H. O. Hartung, of Glendale, vice president and Warren Kramer, of Jefferson City, secretary-treasurer.



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Men and Jobs

Robert J. Potts of Harlingen, Tex., for many years professor of highway engineering at Texas A. & M. College, will become a member of the Texas Highway Commission on Feb. 15, 1949. He is now serving his second year as president of the Texas Good Roads association. His colleagues on the Highway Commission will be two other men who have been presidents of the association—John Redditt of Lufkin and Fred Wemple of Midland. After being graduated from Texas A. & M. College, Potts taught highway engineering at the college. He then operated a sand and gravel business at Waco. He has written two books on road-building.

Promotion of **Andrew R. Mulligan**, of Syracuse, to district engineer in charge of the Rochester office of the New York State Department of Public Works has been announced. Mr. Mulligan, who has been assistant district engineer at the department's Syracuse office since 1932, will succeed **J. Burch McMorran**, now chief engineer of the department. After several years service with the old State Engineers Department Mr. Mulligan was transferred to the Syracuse office of the Department of Public Works in 1915 as county assistant engineer in charge of highway maintenance for Onondaga County, a post which he held until 1927 when he was promoted to associate civil engineer in charge of canal operation and maintenance in the Syracuse District. In 1932 he was again promoted to assistant district engineer for the Syracuse district and as such has had supervision of highway construction in Central New York.

W. M. McMullen, county engineer of Renfrew County, Ont., has resigned.

Harry T. Campion has resigned as superintendent of the Definance, Ohio, Municipal Water Works. He was superintendent of the municipal plant from its start in 1920 until 1926. He served with the Grand Rapids, Mich., water department for 12 years, and returned to the Defiance post in 1942.

John C. Mellett, a member of the Indiana Flood Control & Water Resources Commission since its organization, has become executive secretary for the remainder of 1948. David H. Harker, who has been acting executive secretary since the resignation of Clyde R. Black, remains as chief engineer for the commission.

M. J. Barrick, district engineer of the Williamsport, Pa., office of the Bureau of Engineering, Pennsylvania State Department of Health, has gone to headquarters in Harrisburg to become office engineer. **Marlin E. Wilt**, assistant district engineer at Williamsport, is acting district engineer of that office. Mr. Barrick has had charge of the Williamsport office since 1925. Mr. Wilt became associated with the bureau in 1937 as assistant sanitary engineer. He served four years in the Army Air Forces during the war, returning to the bureau in 1946.

Ronald M. White, assistant city engineer in charge of designs for Kansas City, Mo., has resigned to join the C. S. Foreman Construction Co.

J. F. Davison has been appointed division engineer, Canadian National R.R., with headquarters at Levis, Que.

Bradford Hayden Cecil, who obtained his civil engineering degree from Duke University, Durham, N. C., in June, now is with the American Car and Foundry Co. in Baltimore, Md.

John L. Haynes, formerly chief of the Construction Division of the Department of Commerce, was recently appointed to the Economic Corporation Administration Mission to Belgium. He is now in Brussels, where he is program review officer. **J. Marshall Mayes** has been named acting chief of Commerce's Construction Division. He was formerly assistant to Mr. Haynes.

Robert Hilton Parrish, who obtained his civil engineering degree from Duke University, Durham, N. C., in June, now is a safety engineer at Atlanta, Ga.

Alexander Macomber, Boston, Mass., consulting engineer, has been appointed by Governor Robert F. Bradford to the Boston Port Authority to succeed ex-Mayor John F. Fitzgerald who has worked for the port's interest for nearly half a century.

Carl L. Torrence has opened an office for the practice of structural engineering under his own name at 106 S. 3rd St., Richmond, Va. Until lately he was director of real estate and engineering services for Southern States Cooperative, Inc.

Leo L. Coulter has been appointed Thurston County engineer at Olympia, Wash., to replace the late William H. Yeager. He has been assistant county engineer for the last two years after previously having been with the state highway department.

OBITUARY

Fred J. Millard, 62, Toledo, Ohio, city division engineer in charge of sidewalks, died Dec. 3. He joined the city division of engineering in 1908, as a rodman, later became assistant engineer, division engineer, and city sidewalks superintendent. He handled most of the sidewalk work in Toledo for the last 20 years, and also assisted in planning and building of sewers, streets, and buildings.

Rupert W. Watson, 46, civil, structural and mechanical engineer with the city utilities in Fort Wayne, Ind., died Dec. 4.

J. L. Lloyd Condon, 43, died at Kentville, N. S., Dec. 1. He was a partner in M. A. Condon & Sons, Kentville, general contractors, and a son of M. A. Condon, founder and head of the business. The son studied civil engineering for three years at Acadia University, Wolfville, N. S., and obtained a degree from the Milwaukee School of Engineering. The Condon's have executed some of the biggest construction jobs in the maritime provinces during the last 20 years, with base at Kentville.

H. Lyle Campbell, 68, construction superintendent in the office of the architect of the United States Capitol, died Dec. 5 in Washington. He had been assigned recently to aid in remodeling the Senate wing of the Capitol. Mr. Campbell went to Washington in 1936. He was director of construction review for the Federal Public Housing administrator before going to the office of the Capitol architect.

Herman Holmes, 76, of Crystal Falls, Mich., a builder of the Pennsylvania Turnpike, died at Fort Bedford, Pa., Dec. 5. His most recent project was a diversion of the Conamaugh River's flow involved in constructing a tunnel for the Pennsylvania Railroad.

Manson W. Cartwright, 67, a former consulting engineer for the Reconstruction Finance Corp., died at Eustis, Fla., Dec. 1. He was a veteran of the first world war.

J. Lester Brown, 44, general superintendent of the Mittry Bros. Construction Co., died at Caney, Kan., Dec. 6. His company is constructing the Hulah, Okla., Dam, for the U. S. Engineers. Mr. Brown took his B.S. degree in civil engineering at the University of New Mexico in 1927. He has worked on many heavy construction projects for the U. S. government and contractors.

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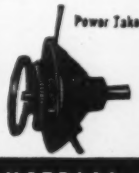

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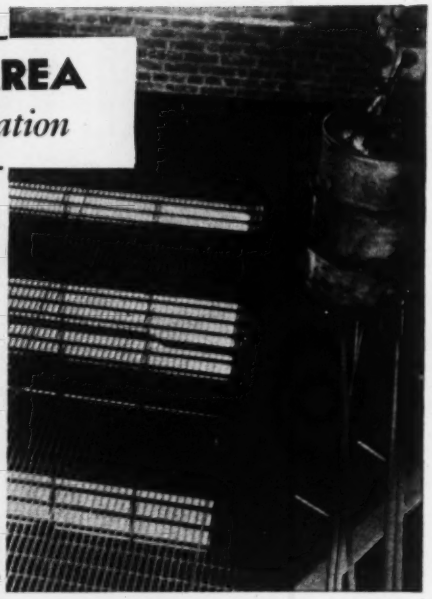

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Henry Earl Graves, engineer of th South Carolina State Highway Depar ment, died Dec. 4 at Columbia. He w a graduate of Clemson College and ha been with the highway department fo more than 25 years. For a time he wa assistant office engineer but since 193 had been federal aid engineer.

Wynne A. Murphy, 57, civil engi neer, and a member of the firm o Murphy, Quigley and Co., builders, die Nov. 28 at Upper Darby, Pa.

W. T. Thompson, 59, Eugene, Ore Oregon state highway department engi neer, died Dec. 8 of injuries suffered in an automobile accident near North Bend, where he was supervising a high way job.

Bids called for repair of Coulee Dam spillway

Bids for repairing the spillway bucket of the Grand Coulee Dam have been called by the Bureau of Reclamation for opening on Dec. 21. The job will also include dredging the Columbia River channel below the dam and repairs to the spillway face.

The spillway bucket of the dam was damaged through erosion caused by boulders and gravel entering the bucket during construction. At least 150 ft. of the 1,650-ft. long bucket is to be repaired.

Work will involve the first use of the floating caisson (*ENR* June 10, Vol. p. 945 and *ENR* July 19, 1945, Vol. p. 73).

Army to ask approval of $25 million Arizona dam

The Corps of Engineers will present construction plans to Congress early next year for the proposed $25,800,000 Painted Rock flood control dam on the Gila River in sourthern Arizona.

Col. Dwight F. Johns, Oakland, Calif., district engineer, reported to a meeting of the ASCE Arizona Section that the Painted Rock project has the endorsement of Arizona and authorization of the U. S.-Mexico Water Treaty.

The state in endorsing construction of the dam, cited protection against Gila River floods that could cause great damage to agricultural land in the Wellton-Mohawk district.

Full construction cost of the dam and $40,000 annual maintenance would be paid by the federal government. Recommendations call for an earth fill dam 174 ft. high above streambed with a crest length of 4,710 ft. to create a flood basin of 2,480,000 acre-ft.